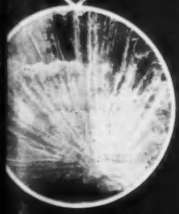
CHEMISTRY



DECEMBER
1948

APR
LIBR

New Synthetic Textile Fiber 1
Orlon Acrylic Fiber 2
Vinyon N Synthetic Fiber 8
Fibers to Order 10
Back Cover Picture:
Spinning Cell 12
New Developments in Rubber 13
For the Home Lab:
Picric Acid 17
Evolution of Photosynthesis 19
Primitive Drugs of Ecuador 21
Radical Combinations Revealed 23
Neutrons Useful in Analysis 24
Classic of Chemistry:
Prediction of the Neutron 25
Packaged Atomic Power 27
Electro-Chemical Corrosion 29
Advances in Oil Chemistry 32
Safety Urged in Chemistry Labs 37
Textile Makers Stress Serviceability 39
Patents on Chemical Products 41
Analyzing the Ocean 45

Editorial:
Ode to Ethylene
Inside Front Cover

25¢

SCIENCE SERVICE PUBLICATION

Ode to Ethylene

➤ MUCH IS OWED these modern, chemical days to ethylene, she with the double bond of carbon. For born of liquid gold, petroleum as oil or gas from earth, this is a mother chemical bountiful in her production of chemical children to do new kinds of work in the world.

The new fibers, Orlon and Vinyon N, described in this issue of CHEMISTRY, are of her tribe, descendants of her substances, by grace of catalysts and chemical intermarriage that has the habit of being so fruitful when ministered to by research diligence and industrial care.

To millions who will wear the new fabrics derived from ethylene, the mere glance at a formula of the simplest organic compound produces an intellectual fright that freezes all thought and attempt at understanding. It is scientific Chinese to most.

More schools should have the courage to present the basic facts of *living* chemistry, as well as the good, old-fashioned inorganic chemistry of H_2O and the common elements and simple compounds. We should not be baffled by a benzene ring or shy away from a polymer.

The familiar $C=C$ is really a very important part of the world today, even more so than in the past. This ethylenic linkage introduces into long chains of carbon compounds a reactive quality that makes them apt to polymerize.

We have a glimpse of the commercial products to come from the newer products of ethylene. We can be confident that there are new compounds for new fibers and other new products still unborn in the chemical laboratories of tomorrow.

CHEMISTRY

Vol. 22, No. 4 | Formerly The Chemistry Leaflet Including The Science Leaflet | December 1948

Published monthly by Science Service, Inc., the institution for the popularization of science. Publication Office: 119 South Frazier St., State College, Pa. Entered as second-class matter at the Post Office, State College, Pa., under Act of Congress of March 3, 1879. Address communications to Editorial and Subscription Office: 1719 N St. N.W., Washington 6, D.C.

25c a Copy; $2.50 a Year. Two-Year Subscription $4; Your Own and a Gift Subscription $4. Quantity Subscriptions, 10 or more copies to same address: $1.75 a Year, $1 for any seven months, 15c each Copy each Month. No charge for Foreign or Canadian Postage.

Editors: WATSON DAVIS and HELEN MILES DAVIS

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Copyright 1948 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS *of Science* (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the E. W. Scripps Estate and the Journalistic Profession.

▶ CONES OF *finished yarn of one of the new synthetic fibers, Vinyon N, are ready to leave the factory and be put to work.*

New Synthetic Textile Fiber

▶ CHEMISTS NOW HAVE a new wool-like fiber that would make sheep envious and a new kind of silky filament that would discourage the industrious silkworm.

Just emerging from the laboratories, a new kind of synthetic plastic will be available in a few years for your overcoat, blankets, underwear and a hundred other textiles you use. There will be many industrial applications.

Made basically from petroleum and other plentiful chemicals, the new fibers cut another line of man's dependence upon agriculture for textiles, including clothing.

Moths will not chew it and decay and weather are resisted for years by the new material. The Army would have used tons in the pest-ridden, humid Pacific war areas if it had been able to get it produced.

Two different fibers are produced by two large chemical companies. They are somewhat different in chemical composition and properties. "Orlon" is the product of E. I. du Pont de Nemours and Co. and it is a polymer of acrylonitrile. It is the long-rumored experimental Fiber A. "Vinyon N" is the product of Carbide and Carbon Chemicals Corporation and it is a copolymer of vinyl chloride and acrylonitrile. Vinyon N was made known early in 1947.

Both of these new fibers are relatives of one kind of synthetic rubber.

CHEMISTRY HALL LIBRARY

Acrylonitrile with butadiene makes an oil-proof synthetic rubber, known variously as Hycar, Parbunan, Butaprene, Chemigum or Buna N. This is not the kind that was selected for major war production, however. Vinyl chloride is a plastic material that is used for shower bath curtains, raincoats, electrical insulation, food packaging, coating fabrics, etc.

Because of the future importance of this new class of fibers, CHEMISTRY gives its readers in considerable detail the facts about Orlon and Vinyon N.

Orlon Acrylic Fiber

The article that follows is in effect the birth announcement of a new synthetic, named Orlon. The paper before the American Association of Textile Technologists meeting in New York, given by Dr. J. B. Quig, assistant manager of the development section, technical division, rayon department of E. I. du Pont de Nemours & Co., has been excerpted to give the detailed and essential facts about this new development.

➤ THE FIRST rayon processes were developed in Europe, and it was not until 1910 that the first rayon plant was established in America. After a period marked by struggles to overcome technical difficulties and obtain consumer acceptance, the growth of the rayon industry became very rapid. This growth has continued steadily year by year until, today, over one billion pounds of rayon are produced in the United States. As a result, rayon has outpaced wool and silk in volume and is now second only to cotton. However, the consumption of rayon is still only a little more than 45.5 per cent of the combined consumption of cotton, wool, silk, and rayon.

The public acceptance of rayon has indicated clearly that a new fiber can be successfully commercialized, if it has outstanding characteristics different from those of the previously available fibers. The success attained by rayon encouraged the Du Pont Company to adopt an extremely generous policy of spending large sums of money for basic and fundamental research, the objective of which was to develop additional fibers which would serve a given purpose better—technically, aesthetically, or in terms of unit function per dollar cost.

We knew that clearly defined but unfulfilled needs for new fibers existed. But, looking back, it appears that we were rather lethargic from the standpoint of working with fiber-forming raw materials which were outside the areas encompassed by cellulose and cellulose derivatives.

Interest in polymers for truly synthetic fibers was slow in developing. However, with a strong faith in the future possibilities of man-made fibers, Du Pont was willing to risk millions of dollars on theoretical possibilities. Encouraged and inspired by the brilliant and classic researches of Wallace Carothers, Du Pont spent several million dollars on the research and development of nylon. This gave the textile industry the first truly synthetic fiber.

The new property levels possessed by nylon have already caused it to be a remarkable success. Nylon is now a definite part of the warp and weft of

the textile industry. The results have not only been profitable to Du Pont but, likewise, to weavers, knitters, dyers, converters, and even the smallest vendor of nylons. Furthermore, the public has benefited enormously from the new standard of value, the rugged performance, the greater unit function per dollar cost, and the easier care of nylon fabrics.

Research on Vinyls

Carother's discovery of the fiber-forming characteristics of linear superpolymers has spurred research men everywhere to investigate the fiber-making possibilities of a host of polymers. As a consequence, a new era in synthetic fiber development is here. Within the last decade, we have seen the introduction of at least a half dozen new synthetic fibers. In quick succession, the American public has been offered a variety of synthetic fibers made from vinyl compounds. They differ from nylon, not only in their properties, but in the character of the polymers from which they are made. Nylon is made by condensation polymerization, wherein a molecule of water is split out. The vinyls are addition polymers, of which the best known in yarn form are designated as "Saran" and "Vinyon." Recently, research has gone forward, here and abroad, on the fiber-making potentialities of polyvinyl alcohol, polystyrene and polyethylene; but these fibers have not yet been commercialized.

Much of the research in this field was greatly retarded during the war but was resumed with renewed vigor at the cessation of hostilities.

The high chemical inertness of "Vinyon CF" fiber, made from a copolymer of vinyl chloride and vinyl acetate, and of the German "PC" fiber, made from after-chlorinated polyvinyl chloride, stimulated research here and abroad in the quest for yarns which would retain sufficient chemical inertness but which could be used at higher temperatures in liquid and gaseous mediums. From this type of research in the United States, the Union Carbide and Carbon Corporation has produced "Vinyon N" from a copolymer of vinyl chloride and acrylonitrile.

Polyacrylonitrile

Concurrently, Du Pont was also exploring the desirability of polyacrylonitrile itself as a fiber-and film-making material from a very broad and pioneering standpoint.

The acrylonitrile polymers are made by polymerizing the monomeric acrylonitrile, a fairly volatile liquid ultimately derived from ethylene and having the following formula:

$$\begin{array}{l} CH-CN \\ \| \\ CH_2 \end{array}$$

Acrylonitrile polymerizes under the influence of catalysts and yields a product of the following type:

$$-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-$$

Acrylonitrile, in its tendency to polymerize, thus behaves similarly to the related substances, vinyl chloride, vinyl acetate, and vinyl alcohol, all of which, either by themselves or in the form of interpolymers, can be converted into textile fibers.

Spinning Problem

With the introduction of nylon, a new method of making fibers by melt

extrusion was developed. Up to the present time, this method of spinning has not been successful for polyacrylonitrile. Spinning by either the wet or dry processes requires solution of the polymer. Success in utilizing polyacrylonitrile as the raw material for Orlon acrylic fiber did not come easily, since this intractable polymer did not yield readily to solvents. Accordingly, the finding of a satisfactory solvent became a major objective.

It was known in the prior art that polyacrylonitriles could be dissolved in concentrated solutions of salts, among which may be cited lithium bromide, sodium sulphocyanide, aluminum perchlorate and calcium sulphocyanide. It may be recalled that wool and certain proteins are also soluble in these salts. Such polyacrylonitrile solutions were made into fibers and films. But only limited progress was made in this direction, due to the limitations of the use of such highly concentrated solutions. Further progress was made when it was found that polyacrylonitrile could be dissolved in quaternary solutions of ammonium compounds, but the fibers produced were far from satisfactory.

Solvents Discovered

Orlon acrylic fiber became a reality with the discovery of suitable organic solvents which can be employed for preparing solutions of polyacrylonitrile. Among these can be mentioned dimethyl formamide, dimethyl methoxyacetamide, tetramethylene cyclic sulphone, the meta- and paranitrophenols, and others.

With these encouraging results at hand, exploratory studies were continued; and, in 1944, a semiworks, using the dry spinning process, was built in Waynesboro, Virginia, under the auspices of the Research Section of the Acetate Division. Until August, 1945, our development work was concerned mainly with determining how Orlon could be used to aid the war effort. It was found that the possibilities for Orlon in military applications, especially in the Pacific Theatre, were of far-reaching importance to the Army, the Navy, and the Air Forces; but the Orlon development had not been brought to fruition when the war ended. By early 1946, Orlon looked promising enough for commercialization; and process development continued. In October, 1948, a decision was made to build a plant for the production of Orlon in Camden, South Carolina. Construction is expected to be started in March; 1949. Approximately 18 months will be required to complete the plant, making production available some time in the fall of 1950.

The success of nylon in contributing to better living, and the new standard of performance and value which it is setting in many types of textile uses, made it necessary for the development section to appraise carefully the properties and the future place of Orlon fiber in textile markets. The importance of doing this is readily understood when it is known that Orlon possesses many of the desirable properties which have been responsible for nylon's growth.

For a long time, our research has been looking for a continuous filament, synthetic fiber having the warm, dry, luxurious hand and dimensional stability of silk in high humidities. We have also been searching for a staple which would have the exceptional

bulking power, high thermal insulation and wrinkle recovery possessed by wool. Still another objective has been to develop a fiber with strong attributes which would allow us to make a contribution to the industrial and domestic fabric fields — a fiber which has extraordinary resistance to outdoor exposure, chemicals, microorganisms and insects, along with high strength, low sensitivity to moisture, good heat resistance and high flex life.

Like Silk and Wool

Five years of searching market exploration, employing a large poundage of Orlon fiber, has convinced us that Orlon is an industrial fiber of the first order. The objective of developing an outstanding industrial fiber has been reached. On the other hand, Orlon continuous filament yarn is the most silk-like synthetic fiber, while Orlon staple is the most wool-like synthetic fiber of which we have knowledge.

Orlon fiber has a combination of properties which will give it a wide diversification of markets and cause it to be suitable for many purposes in which nylon and the rayons will not equal its performance. For one thing, Orlon's resistance to outdoor exposure is so good that we feel that it is the best fiber we know of, natural or man-made, for outdoor uses.

This single salient characteristic of Orlon will extend the frontiers of utility of industrial and domestic fabrics. However, if we pyramid the other attributes of Orlon along with its sunlight resistance—i.e., high dry and wet tensile strength, high resistance to stretching, high flex life, rapid drying, bonding to resins and rubbers, dimensional stability to heated gases and liquids, resistance to acids and acidic fumes at high temperatures, resistance to insects, molds, mildew, and other microorganisms—then the broad utility and versatility of Orlon as an industrial and domestic yarn can be viewed in the proper perspective.

Since nylon has greater abrasion resistance, retains a greater percentage of its strength in air at higher temperatures, and has a much better resistance to alkalies than Orlon, it is apparent that Orlon will supplement, rather than compete with nylon in the industrial and domestic fabric fields.

The trade-mark "Orlon" does not apply to a single fiber or yarn having a definite set of properties, or made by any definite process, but rather to various types of Orlon acrylic fibers. All of these fibers, to date, have possessed many of the properties of the original Orlon fiber but, in addition, have distinctive characteristics of their own.

Physical Properties

Orlon is strong and has a good elongation or extensibility. The ratio of loop and knot tenacity to straight tenacity, while not so high as found in nylon, is of a high order. The elastic recovery is good but is not as outstanding as nylon. On the other hand, the modulus or resistance to stretch of Orlon is very much better than that possessed by nylon. While the shrinkage in boiling water is low in comparison with nylon, this shrinkage of nylon is not an inherent difference but results from a difference in process. Orlon is more hydrophobic than nylon. The specific gravity is closely similar to nylon. Cellulose fibers are approximately 28 per cent heavier per unit volume than Orlon and nylon. The flex life of Orlon is outstanding,

while its abrasion resistance is lower than nylon and is in the same range as cotton, which is at present the principal industrial fiber.

Outdoor Resistance

With regard to outdoor resistance, Orlon stands in a class by itself. In an outdoor exposure test of yarn, conducted in Wilmington, Delaware, involving Orlon, silk, nylon, linen, cotton and viscose process rayon, Orlon retained 77 per cent of its strength at the end of 1½ years after all of the other fibers had completely failed. Exposure tests conducted on natural fabrics in Florida, where the effects of ultraviolet light are intense and indusrial fumes are absent, have shown that Orlon has excellent resistance to sunlight alone; while other exposures of the same fabrics in the heavy, fume-laden area of Philadelphia have shown the remarkable resistance of Orlon to the combined influence of sunlight, smoke, soot and acidic fumes. These tests have shown that, when the time of exposure is sufficient to cause the rayons to lose 100 per cent of their strength, Orlon has retained 85 per cent of its original strength.

Additional tests, involving Orlon awning fabrics (painted and Aridye) versus cotton (painted and vat dyed) fabrics exposed over a year in Florida have corroborated the great superiority of Orlon over cotton with respect to resistance to ultraviolet light, mildew, molds, and degradation by industrial smoke, soot and fumes.

Chemical Resistance

Orlon has good-to-excellent resistance to mineral acids, fair resistance to weak alkalies, and is not harmed by common solvents, oils, greases, neutral and most acid salts. The alkali resistance of Orlon is adequate in all boil-off, scouring and dyeing operations. Orlon's stability in sodium hypochlorite bleaching is outstanding in comparison with the rayons, cotton and nylon.

Biological Resistance

The resistance to aerobic bacteria, soil bacteria, fresh and salt water bacteria and insects, including firebrats, carpet beetles, clothes moths, and German cockroaches is excellent. Orlon has been exposed to soil burial tests conforming to A.S.T.M. and O.Q.M.G. specifications and has been compared with sisal, treated and untreated manila and cotton, jute, hemp and nylon. In these tests, Orlon maintained 90 per cent of its original strength and was superior to the other fibers.

Effect of Temperature

The physical properties of Orlon improve at extremely low temperatures, and there is no noticeable rigidity of the fiber imparted. While approximately 50 per cent of the tenacity is retained at 302°F., the residual tenacity is equivalent to that of cellulosic fibers at that temperature. All of the original strength of Orlon is retained after an exposure of 32 days in air at 257°F.

Other Properties

Orlon, like all thermoplastic yarns, shows different degrees of shrinkage in different mediums and fabrics and should be stabilized for the particular end use. Excellent dimensional stability has been attained with domestic and wearing apparel fabrics.

During finishing operations, the Orlon fabric should be exposed to temperatures higher than those which will be encountered in use, in order to secure the proper dimensional stability.

▶ A POWDER *like fine flour is the form of Vinyon N before it is treated with the solvent and squirted into filaments as shown in the back cover picture.*

Orlon exhibits a surface wetability which may be predicted from an examination of its bark-like striated surface. The adhesive strength produced between Orlon, the elastomers GR-M and GR-S, and silicone resins has been satisfactory.

Orlon will burn. It does not flash burn when measured by standard test procedures. A lighted cigarette placed on marquisette curtains, awnings, or blankets made of Orlon fiber did not cause these articles to burn.

Both the polymer from which Orlon fiber is prepared and the yarn itself have been investigated for possible toxicological hazards; and both have been rated as non-hazardous. No dermatitis was produced. The products of combustion of Orlon yarn in both large and limited quantities of air are of the same toxicity as the combustion products of silk and wool.

Orlon is of interest in electrical laminates, because of the following significant properties: Low moisture absorption, low dielectric constant at microwave frequencies, low loss tangent at microwave frequencies, and resistance to fungus growth.

In its microscopical structure, the Orlon fiber has some characteristics which make its identification possible. The general appearance is similar to Vinyon, but the surface of Orlon is irregularly striated to varying degrees.

The shape of the majority of the cross sections is "dog-bone" or "dumbbell" in character and is similar to Vinyon and Vinyon N. Clover-leaf shaped cross sections are also prevalent. A distinguishing characteristic is the air-filled pockets or vacuoles of minute diameter which are found in the cortex of the fiber. The fiber possesses a

skin or cuticle having a higher density than the cortex; and this outside layer does not contain the airfilled pockets or vacuoles. Orlon has exceptional bulking power.

A yarn, to have the maximum utility and versatility in wearing apparel and domestic uses, must be dyeable. The first Orlon fiber produced commercially at Camden, South Carolina, will exhibit the present dyeing characteristics, which are limited in scope. The present yarn, which is now being produced in a pilot plant at Waynesboro, Virginia, can be dyed to pastel shades with certain acetate and basic colors, by orthodox dyeing techniques at the boil. Excellent washing fastness is obtained in all cases, but the light fastness of basic colors is unsatisfactory. The present fiber can be pigment dyed and pigment printed, by use of water-in-oil and oil-in-water emulsions containing resin binding agents.

The DuPont Co. trade mark is "Orlon."

Vinyon N Synthetic Fiber

This summary of the properties, uses and history of the vinyl chloride-acrylonitrile resin fiber, produced by the Carbide and Carbon Chemicals Corporation, has been prepared from material published since the new family of vinyl fibers, trade-marked Vinyon N, was announced in February 1947. Readers of CHEMISTRY *particularly interested will profit by reading the detailed article by E. W. Rugeley, T. A. Field, Jr., and G. H. Fremon in Industrial and Engineering Chemistry, Vol. 40, p. 1724, September 1948.*

➤ VINYON N is a younger cousin of an older product, Vinyon without the N. Fiber made of the copolymer of vinyl chloride and vinyl acetate has been used commercially for over a decade under the name of Vinyon. The combination of properties in this fiber is different from any other textile material: High strength, noninflammability, resistance to chemicals of many sorts, minimum water absorption, and lack of damage from decay or mildew. It did have temperature limitations and was attacked by some organic solvents, which limited its application to special uses.

A search for an improved material led to the bringing together of vinyl chloride and acrylonitrile as a copolymer. The partnership of these two compounds was not entirely novel, because acrylonitrile was copolymerized with various vinyl and acrylic compounds as early as 1931.

Polymers that contain large amounts of the acrylonitrile are difficult to handle the way some plastics are fabricated, that is, by causing the resin to flow by pressure when heated. Neither do they plasticize easily.

Acetone was discovered to be a solvent for the copolymer, although the polymer of both of the ingredients was not within the useful range. This opened the way to research and use of the copolymers in fibers as well as film and coatings. Thus a new plastic was born and named Vinyon N.

From 56 to 60 per cent of vinyl chloride is used in the usual Vinyon N. The resin is produced in the form of a fine powder that resembles flour. It can be fluxed into solid material and here are some applications for the molded resin.

In the manufacture of continuous

filaments of fine and medium sizes, such as now being made at Charlestown, W. Va., acetone solution containing about 25 per cent resin is forced through stainless steel spinnerets. Fine streams of the solution are thus squirted out down a 20-foot tube in a rising stream of hot air that evaporates and takes off the acetone and leaves filaments that are wound on spools. (See back cover illustration).

Because strength increases generally with the amount that the fibers are stretched to orient the molecule in the fiber, the yarn is drawn or stretched at a fairly high temperature (117 to 170 degrees C.) for most uses. The stretch is 10 to 13 times and this naturally decreases the diameter (dernier) of the filament.

Yarn as it comes from the spinning cell shrinks about 25 per cent when it is heated above a temperature that would release its strain. Stretched yarn, too, shows shrinkage beginning at about 65 degrees C. The yarn stretched to a certain degree and heated to a certain temperature shrinks an amount that can be reproduced under the same conditions.

This controllable shrinkage makes possible a number of applications. The untreated yarn as it comes from the spinnerets may be woven. Then it can be stabilized by shrinking in fabric form and this gives tight construction to the textile. Fabrics may be woven of yarns that have different shrinkage under the same temperature treatment and this can be made to produce crepe, seersucker and terry cloth effects.

Vinyon N is thermoplastic. This property may be used to shape fabrics. Permanent creases can be placed in such fabrics, thus making pressing unnecessary. Garments that are likely to be subjected to perspiration, that damages many fabrics, can be made safely from Vinyon N. Because the material is resistant to fungus and molds, it is proposed for use in shoe linings, lines, twines and nets used in salt water, mosquito nets, storage containers, etc. Because it will not support burning, it is superior for draperies, bedding, upholstery and clothing likely to encounter fire. It is strong when wet or dry and the chemists who make it see it used, for that reason, in ladies' stockings, men's socks, thread, surgical sutures, fishing lines, dental floss and pile fabrics.

Vinyon N is readily dyed by procedures more or less the same as for acetate rayon, although higher temperatures are needed for the dyebath. The stability of dyed Vinyon N in natural sunlight varies with the dyestuff and the type of yarn. The dye does not take very well on Vinyon N when acetate rayon and nylon are present in the same bath, because the other fabrics absorb the color at a lower temperature. This can be used to give natural fabric effects for Vinyon N while the other fibers are dyed.

Vinyon N resists most chemicals and solvents. It is not affected by water and therefore dries quickly. And it is very resistant to insects, fungus and mildew.

The active service of Vinyon N is largely in the chemical industry at the present time where it is used in filters, valve packing, clothing for chemical plant operators, tapes, etc., all uses that utilize its unusual properties.

But in the future when more of the

fiber is available, it will be used in households, upon our persons, and in many industries. It is one of the chemical materials of our future.

Fibers to Order

▶ "KNOWLEDGE of linear polymers has now reached a stage of development which makes it easy to synthesize a new fiber-forming polymer," Dr. G. Preston Hoff, assistant manager of the Technical Division of the Du Pont Company's Rayon Dept., said recently.

"The difficulty arises in finding a material with the right combination of properties to fill needs not satisfied by existing fibers," he continued, in an address on *"Research and Synthetic Fibers"* before the chemistry and chemical engineering faculty, students, and alumni of The Ohio State University.

His talk was made in connection with ceremonies marking the 75th anniversary of the establishment of the chemistry department at the university, from which Dr. Hoff received his doctor of philosophy degree in chemistry in 1925.

Dr. Hoff said that the matter-of-fact words in the title of his talk "all but conceal the drama of a great story of science and industry that almost perfectly reflects the partnership between university and industrial science. I speak of the linkage between the men in their classrooms and laboratories, working under the guidance of wise teachers and in an atmosphere of academic freedom and adventure, and industrial chemists in free America beyond university campuses."

He stated in part:

Beginning around 1925, and continuing through the present time, a revolution in textiles has been taking place in America. In one of its manifestations, it has appeared as a part of a social revolution. And in another, as a part of an industrial revolution. It is now gathering such momentum as to make it appear that the last 23 years were only a beginning.

Consider for a moment the social aspects of what I have chosen to call a revolution. This revolution began, of course, with rayon, the first man-made fiber. When research transformed the fragile, shiny, and unlovely fibers of what once was called "artificial silk" into warmly beautiful fabrics of rayon, raiment as appealing to the eye as the silks of the East were to be bought by American women at reasonable prices.

It should not be necessary to dwell upon another aspect of the revolution. It gave America a new industry.

When our company began rayon manufacture in 1921, there were only two rayon companies in the United States. They employed but a few thousand people. Today no less than 15 rayon-producing companies directly employ 67,000. They serve approximately 150 weaving mills, employing another 112,000. The industry includes 575 rayon converters, mostly small concerns, and 585 dyeing and finishing firms. About 3,500 companies make rayon cloth into finished garments sold through some 9,000 retail outlets. It all adds up to an industry of more than 13,000 separate business enterprises with a total of one and a quarter million workers.

I sometimes wonder if in the patient accumulation of knowledge, it could be possible that we may be working by evolutionary processes toward a time when there will always be work for men who want it. Certainly we can say that chemists in their laboratories have provided steady work to countless thousands of men outside the laboratories. For there can be no question but that the American textile revolution was given its vital spark, is driving force, by research.

Industrial research does not end with the discovery of a new product. Nearly always, much more time and money are spent in finding a way to make a product at a suitable price level—and in improving the quality —than was spent in discovering the product.

Among the beneficiaries of this kind of research are men to whom the new product gives employment, since process development and constant process improvement raise worker productivity, which in turn is reflected in higher wages. The function of research in making the individual worker more productive may be illustrated from the experience with synthetic fibers. For some of these, the production of one man-hour is equivalent to the output from between 65 and 100 man-hours in the silk industry.

The diverse scientific knowledge which made possible today's synthetic fiber industry came from scientists in virtually every corner of the world. This demonstrates with abundant clarity a truth which many who are not scientists sometimes overlook; namely, that scientific isolationism is as outmoded as political isolationism.

If we but stop and look about us, we will see evidence on every hand of a close relationship between the rate of scientific discovery and development and the freedom with which scientific information may be exchanged among scientists throughout the world. All phases of scientific learning are interdependent. Truly a finding in one field provides the key to a secret in another.

Tracing the development of nylon and the more recently announced Orlon acrylic fiber, Dr. Hoff said that the concept of truly synthetic fiber-forming polymers was slow in developing. It is upon this concept that the new science of synthetic fibers is based. It took a genius with a mind free of preconceptions to show the way. These requirements were supplied by the late Dr. Wallace Hume Carothers who directed the research which led to the development of nylon.

Orlon, which was announced by Du Pont a few weeks ago, makes available to the textile industry a synthetic fiber with a new set of characteristics. It possesses a combination of properties which make it useful for many purposes for which we would not recommend either nylon or rayon. For one thing, its resistance to sunlight makes it the best fiber we know of, natural or synthetic, for use in outdoor fabrics. In addition, its chemical resistance recommends it for filter fabrics and for the bags used in the collection of hot dusts. It may have a place in the collection of fly ash from factory chimneys.

Speaking of the cost of the broad, continuing research necessary to develop the synthetic fiber industry, Dr. Hoff referred to the growing tendency

in this country to regard bigness in itself as inherently evil and, therefore, meriting distrust for no better reason than its size. Thirty years ago, rayon attracted little interest in the textile industry, while nylon and 'Orlon' weren't even gleams in the fiber chemist's eye. Ye tbusiness was willing to ist's eye. Yet business was willing to possibilities.

The Du Pont Company, only one part of the total rayon industry, has spent more than 30 million dollars on rayon research since the beginning. Comparable sums have been involved in the case of nylon and will be required for 'Orlon.' Only a large organization can engage in research of that magnitude.

To be sure, from the risks Du Pont and others in the industry took, profits were made. But they were made as well for the weaving mills, the knitters, the dyers, the finishers, the converters—and among them all are small firms, some of them one-man enterprises. Furthermore, the public benefited enormously when these new materials were made available to them.

American industry needs both large and small business enterprises. There are many jobs which can be done to advantage by small businesses — including even one-man enterprises — but only large concerns could have afforded the research expenditures and plant investment that were needed to build up the American synthetic fiber industry.

"I like to think," concluded Dr. Hoff, "of big business in America as being big because America needs bigness to do some of the big jobs which still lie ahead."

Samples of Fibers Available

If you want actual samples of some of the synthetic and artificial fibers, related to Orlon, and Vinyon N, you can obtain units of Things of Science. A few extra packages of these interesting specimens are on hand and will be furnished to readers of CHEMISTRY *for $.50 each. These do not contain samples of the new fibers but of their predecessors and chemical relatives. Ask for vinyl resin No. 85, nylon No 57, rayon No. 34. Send Science Service, 1719 N Street, Washington 6, D.C. $.50 for each kit desired.*

On the Back Cover

➤ HOW SYNTHETIC *fibers are formed out of the material from which they are made. In this case Vinyon N "dope" as it is called in the factory is forced into a spinnerette at 400 pounds per square inch pressure and issues through 40 holes as fine filaments. They dry and lose the solvent in which the plastic is dissolved as they drop down a vertical, 20-foot spinning cell.*

Man-Made "Cold" Rubber Promises Better Tires

New Developments in Rubber

MAN-MADE "cold" rubber makes markedly superior tires and other products and surpasses the natural tree-grown rubber. It is now going into large-scale production in America's chemical rubber plants.

What is happening is a new chapter in creative chemistry. During the recent war scientists made rubber from petroleum. They made this nation independent of unavailable natural rubber and gave us the essential tires for military and civilian transport.

Now the famous war-time GR-S rubber is being surpassed by post-war development of low-temperature manufacture, new chemical catalysts, and superior carbon black for compounding.

The rather chilly temperature of 41 degrees Fahrenheit, just nine degrees above freezing, is being used in the major cold-rubber production. The temperature at which standard GR-S rubber is made is 122 degrees Fahrenheit.

Over half of the operating capacity of the government-owned synthetic rubber plants, 200,000 out of 376,000 tons per year, is now in the process of being converted to cold-rubber production through installation of the refrigerating equipment necessary. Present plants do not need to be changed except to install tanks, compressors and other machinery for working at the lower temperature necessary. Eight out of the nine operating plants (all but the Akron plant) are being converted.

Glowing reports of the superior qualities of cold rubber have hastened the rush to its production. Synthetic rubber is now at least as good as the natural product, and most reports credit the low-temperature sort with being 20% to 40% better in wear. It does not heat up when tires are run at high speed any more than the natural sort, which was a fault of the older synthetic tires.

You may be getting some of the new cold rubber in tires that you buy without knowing it because tires made from it are not being labeled or advertised as such due to the present small production. In about a year most of the tires made are expected to be made with cold rubber.

Butadiene and styrene, polymerized together, are used to make cold rubber just as these two chemicals are the basic materials of the standard GR-S rubber. In polymerization, big molecules are made out of little ones. One key to low-temperature rubber production is the new sort of catalyst. In rubber technology, catalyst means an oxidizing agent that promotes polymerization and is used up in the process.

In the older synthetic rubber manufacture, potassium persulfate was used as catalyst, while in the cold-rubber process cumene hydroperoxide is used. This organic peroxide was worked out in the University of Minnesota

laboratories under the direction of Dr. I. M. Kolthoff and is a key ingredient of the low-temperature process, making it possible to complete the chemical reaction in a reasonable time, despite temperature.

Soap of fatty acid or rosin type is used in any kind of synthetic rubber formula in relatively large quantity to emulsify the chemicals used. More soap is used than styrene, one of the two chemicals that constitute the rubber.

In compounding the synthetic rubber into vulcanized products, such as tires, a new kind of carbon black, finely divided carbon filler for the rubber, is contributing greatly to the quality and economy of the product. This HAF or furnace black as it is called, is made from oil or enriched natural gas.

Since synthetic rubber is a government operation growing out of the war situation, its price is controlled and set by the Office of Rubber Reserve. At present it is 18½ cents a pound which compares with the current 22½ cents a pound for natural rubber which is controlled by the British monopoly. Synthetic cold rubber is therefore cheaper as well as better than the natural material.

Latex rubber used in cord tire dipping, adhesives, rubber foam, textile coating, etc., is also being made by the low-temperature process with development of high gum tensile strength.

Because the synthetic rubber development is a government-industry undertaking, the cold rubber research and production is largely cooperative. Various rubber companies and research laboratories exchange information and work together.

The next step in cold rubber production will be to apply even lower temperature in hope of getting better and better quality rubber. One rubber company has made small scale polymerizations at as low as 40 degrees Fahrenheit below zero, and some of this rubber has been tested in tires. Below-freezing processes are receiving fairly large scale, semi-commercial trials, with 14 degrees and 0 degrees as the temperatures being used. When subfreezing levels are encountered, anti-freeze must be used in the water, just as in automobile radiators. This complicates the process. The lower temperatures also require more refrigeration.

Cold rubber promises to withstand better the arctic temperatures that trucks and other equipment must encounter in case of another war. Rubber made at 41 degrees also does not crack as easily as ordinary rubber.

Hints of the possibility of low-temperature rubber production antedate the government rubber program that began in 1940. It was early recognized that low-temperature polymerization would produce rubber of better quality, but the 122-degree temperature was adopted because the emergency was great and the standard process gave known results with the reaction running 14 hours. During the war the "speed-up" chemicals increasing the polymerization rates at low temperatures were developed, and German experience with low temperature rubber recipes became known. With the end of the war, the effort to improve the process could be resumed. The use of what is called

the "redox" system, involving oxidizing ("catalysts") and reducing agents, was refined and applied, with the practical results coming this year on any considerable scale.

Most of the rubber companies contributed to the development. The first pilot plant production of low temperature polymers was made by Phillips Petroleum Company in the late spring of 1946, while shortly after the middle of 1946 Goodyear produced a ton for experimental use. The U.S. Rubber Company made the first plant scale run of low temperature rubber experimentally in the summer of 1947, while the Copolymer Corporation at Baton Rouge, La., after pilot plant operation the same year, converted half of its 30,000-ton capacity to 41-degree rubber early this year.

Plants now being converted to cold rubber production are: Copolymer Corp., at Baton Rouge, La., U.S. Rubber Co. at Naugatuck, Conn., and Borger, Tex., Goodyear Synthetic Corp. at Houston, Tex., and Los Angeles, Calif., Firestone Tire and Rubber Co., at Lake Charles, La., B. F. Goodrich at Port Neches, Tex., General Tire and Rubber Co., at Baytown, Tex.

Guayule, American Rubber

➤ The Charles Goodyear medal of the American Chemical Society was awarded this year to a retired chemist, Dr. David Spence, Pacific Grove, for his work on guayule rubber, the only natural rubber commercially made in the United States.

The medal is a tribute to Charles Goodyear, credited with being the inventor of rubber vulcanizing. The Scotch-born Dr. Spence is honored for his contributions to the growth of the guayule shrub and the production of rubber from it. He is an outstanding authority on rubber chemistry.

Guayule, a native American plant, was one of the most promising sources of domestic natural rubber during the years when the foreign supply was cut off and before satisfactory synthetic rubber was being produced. Extensive plantings of the shrub were made in the Southwest and rubber was made from it. About two years is required to bring a guayule plant to the harvesting stage.

Other proposed sources of homegrown American rubber offered less promise. A Russian dandelion called kok-sagyz was proposed but its rubber yield is much less than that of the guayule shrub. There is rubber in various species of milkweeds, spurges and goldenrods, but the content is low and extraction is difficult.

Rubber Powder in Asphalt

➤ Rubber in asphalt is reported to make an improved road surfacing material. A 5% to 10% rubber powder mixture with asphalt gives a surface with longer life, more resistant to wear, and with better anti-skid properties, according to authorities in London.

This is indicated in a recent report of the British Rubber Development Board. The conclusions of the board are based on its investigation of experimental stretches of rubber-asphalt roads in the Netherlands. Some of these stretches have now had a 10-year tryout. One, which had been subjected to very hard usage during the war years and on which little maintenance had been carried out, was in first-class condition when compared

with adjacent stretches containing no rubber.

A Netherlands organization, together with an associated group in the Netherlands East Indies, carried out prewar research into the effects of the addition of small quantities of rubber on the properties of asphalt. It was found that the addition of from 5% to 10% of rubber powder affected the properties of the material when applied to roads in such a manner that penetration, resistance to impact, softening and lessening flow were particularly improved.

The reason for the improvement, according to the Rubber Development Board, is that the rubber powder slowly absorbs the light constituents of the asphalt, rendering it elastic and reducing its tendency to flow. Heat penetration seems also to be reduced. The rubber-asphalt roads are reported to be less soft in summer and less hard in winter than the asphalt roads without the rubber powder.

Rubber and Plastic

➤ A NEW, tough, lightweight material made of combinations of natural and synthetic rubber with plastic resins has been manufactured by the Goodyear Tire and Rubber Company.

Copolymer resins with a high styrene content are combined with natural or synthetic rubber in the group of materials which have been given the name Tuf-Lite. First applications include several types of sports equipment such as helmets for football or polo, golf club heads, golf ball covers and both bowling balls and pins. Other uses for the material include mildew-resistant carrying cases and containers, clicker pads, electrotype printing plates and other articles which need impact resistance and waterproof qualities.

Wide range of qualities, including colors, is possible with the resin-rubber blends, Goodyear scientists have discovered.

Leather Safe from Mildew

➤ LEATHER GOODS, treated with a new dressing developed by the National Bureau of Standards, is safe from mildew and other fungi even under tropical conditions.

The important ingredients of the new dressing are 20 per cent of a mixture of equal parts of neatsfoot oil and mineral oil, 2 per cent paranitrophenol, 10 per cent cyclohexanone, and 68 per cent either perchloroethylene or Stoddard's solvent. The first preserves flexibility, and the second is the fungicide. The perchloroethylene is preferred over Stoddard's solvent because it is non-inflammable.

This formula is now being used by the Office of the Quartermaster General of the Army for the treatment of shoes and other leather items which are to be placed in storage. It is also being used for reconditioning combat boots that have become mildewed and stiffened in storage.

The consumption of industrial alcohol for making synthetic rubber is triple the total prewar consumption for all purposes.

Picric Acid

by Burton L. Hawk

Picric acid is a versatile compound with a three-fold personality. It serves as a dye, an antiseptic, and an explosive. During the first World War picric acid was used to treat the wounds that picric acid caused.

Picric acid forms bright yellow crystals. It is only moderately soluble in water, more so in alcohol or benzene. It was obtained by the action of nitric acid on indigo as early as 1771. It was introduced as a yellow dye for silk in 1849, as an explosive in 1871 and later as a bactericidal agent in the treatment of burns.

Preparation

Picric acid, or trinitrophenol, is obtained by the sulfonation of phenol and then treating the resultant product with nitric acid. The direct action of nitric acid upon phenol will result in the oxidation of the phenol rather than nitration. Hence the reason for sulfonating phenol first to obtain primarily *p*-phenolsufonic acid. The latter is then nitrated to form trinitrophenol.

Place 2 grams of phenol (carbolic acid) crystals in a dry flask. Add 2.5 cc. of concentrated sulfuric acid, and mix thoroughly by shaking the flask. Now heat the mixture on a water bath for about 15 or 20 minutes. This can easily be accomplished by immersing the flask part way in a large evaporating dish filled with boiling water. Do not attempt to heat the flask directly.

Next, *thoroughly* cool the mixture by immersing the flask in ice water. When cool, place near an open window and cautiously add 7½ cc. of concentrated nitric acid. A violent reaction will take place and large volumes of brown fumes will pour out of the flask. Although vigorous, the action is harmless. Take care, however, not to inhale the brown fumes. After the action subsides, heat again on a water bath for ½ hour. Then add 25cc. of water and immerse the flask in ice water. A brilliant yellow precipitate of picric acid will separate. Filter the crystals and wash thoroughly with water. Finally, recrystallize from a mixture of one part of alcohol and two parts of water. Do not attempt to dry the crystals.

Picric acid explodes when rapidly heated or by percussion! Therefore keep the compound damp. If you care to save it, we suggest you keep it in aqueous solution. Commercial picric acid contains about 10-20% added water for safety.

Reactions

The dyeing qualities of picric acid can easily be demonstrated by immersing a piece of silk or wool in a moderately concentrated solution. The cloth will be colored a brilliant yellow. Picric acid also stains the skin yellow, as perhaps you have noticed if you have not been working carefully.

When picric acid is heated with chlorinated lime solution, chloropicrin is formed and can be detected by its

pungent odor. Chloropicrin was one of the poison gases used during the first World War. It acts as a lung irritant, causing severe coughing, crying and vomiting.

Picric acid forms many colorful compounds. Here are just a few of them.

Add a solution of copper sulfate to a solution of picric acid, and pour in a little ammonia. A beautiful green color is obtained, consisting of hexagonal shaped crystals which polarize light. This reaction serves as a delicate test for picric acid.

To a solution of stannous chloride, add enough sodium hydroxide to dissolve the precipitate formed, then add the clear solution to aqueous picric acid. A reddish-tan precipitate is obtained.

On adding zinc and dilute sulfuric acid to picric acid, a yellowish-red liquid is formed. If this be added to alcohol and filtered, it will eventually turn green, then blue, and finally violet.

A blood-red color is obtained by heating picric acid with sodium hydroxide and potassium cyanide. *(Potassium cyanide is deadly poisonous. It must be handled with extreme care!)*

When heated with potassium ferrocyanide, picric acid produces a sky-blue color. This will gradually change to red-violet.

Epitaph

With the advent of many efficient synthetic dyes, picric acid no longer is used in this capacity.

And with the coming of the atom bomb, it is outmoded as an explosive.

Finally, with the introduction of penicillin and sulfa drugs, its use in the medical field is being curtailed.

Poor picric acid! It has seen better days!

New Glass Withstands Heat

➤ A NEW TYPE of glass can be heated to 1,800 degrees Fahrenheit and rapidly cooled without breaking. It is particularly suitable for sun lamps and laboratory glassware.

The new glass, called vycor and invented by Dr. Martin Nordberg and Harrison Hood of the Corning Glass Works, consists almost entirely of silica. It is made from a soft, alkaline glass, molded or blown in the conventional way, which is then immersed in hot acid and the alkali dissolved and washed out. When the glass is heated to 2,000 degrees Fahrenheit, the pores close and it shrinks to about two-thirds its original volume.

The final product can be used continuously at a temperature of 1,600 degrees without losing its strength or clearness. If heated to more than 1,800 degrees for prolonged periods, it becomes cloudy and opaque upon cooling. The opacity, however, does not affect the strength of the glass.

A chemical plant to produce chlorine and caustic soda in Turkey will be in operation this year; another plant for making chrome chemicals is planned.

Green Plants Are Climax in Nature's Use of Sun Energy

Evolution of Photosynthesis

➤ GREEN PLANTS are the latest method that nature has developed to use the energy of the sunshine, Dr. C. B. van Niel, microchemist of Stanford University's Hopkins Marine Station, Pacific Grove, Calif., is telling scientists in a series of Sigma XI national lectures being given throughout the country.

Coming as the climax of a long line of evolution, the method of photosynthesis used in green plants of today is self-sufficient and an improvement on earlier natural methods of building complicated chemicals out of air and water.

Modern plants, with their green chlorophyll, utilize the energy of the light from the sun to break down molecules of water. They build the hydrogen thus obtained, along with the carbon dioxide they take from the air, into their plant structures. The oxygen they discard in this process maintains the balance of nature and the constitution of the air.

The earliest plants, Dr. van Niel is telling his scientific audiences, could not have made use of this complicated process which combines two radically different mechanisms: first, the photochemical reaction; second, the liberation of molecular oxygen.

Evidence has been found, Dr. van Niel reports, that certain purple bacteria make use of a simpler kind of photosynthesis. This method may have preceded that which takes place in the green chlorophyll. It is accomplished by a photochemical decomposition of water as in green plants. In both types of photosynthesis the hydrogen is transferred to carbon dioxide. But only in green-plant photosynthesis is oxygen evolved. In bacterial photosynthesis an oxidation product other than oxygen takes its place, and this must be continuously reduced. That requires the simultaneous oxidation of a reducing substance, for example a secondary alcohol. All these reactions take place under the influence of various enzymes.

It is reasonable, Dr. van Niel found, to regard the evolution of photosynthesis as proceeding from organisms with highly developed synthetic mechanisms but not yet endowed with photochemically functional pigment systems.

The pathway of development would then lead in the direction shown by the mechanisms in use by the purple bacteria. Their pigment systems were present in their colorless ancestors, but they were not yet independent of extraneous reducing chemicals.

The next step in the evolutionary sequence, Dr. van Niel reports, would then be concerned with changes whereby the "oxidation product" of the photochemical reaction becomes capable of self-regeneration through

the elimination of molecular oxygen. This is the mechanism operative in green plants.

Interpreted in this manner, green-plant photosynthesis appears as the ultimate result of that line of physiological evolution which represents the gradual development of synthetic mechanisms, and in which the organisms become progressively more independent of an external supply of reducing substances. Only with green-plant photosynthesis has complete independence been acquired.

Girl "Guinea Pigs" for Iron in Diet

➤ SIX LIVELY 13-year-old girls of assorted sizes spent their entire summer vacations as "guinea pigs" in a food and nutrition research project at Cornell University. They helped scientists study how much iron a 13-year-old girl needs in her diet for good health. This is the first time such a project has been undertaken.

Being subjects wasn't tough, reported the girls — "it was a lot of fun, like a summer houseparty. Besides, we got an allowance of $3.00 a week."

They slept two girls to a room in a college apartment, got up at 7:30, made their beds, and went for a short walk before breakfast. A series of rotating chores followed — dishwashing, keeping charts, etc. They played games, went on hikes, attended lectures and did almost anything except take into their mouths unauthorized food or liquid. That is why swimming was taboo. Lake water isn't properly distilled. They could spend one Saturday night at home, but had to take a box breakfast with them. If they got too thirsty while away, they could drink city water if they measured it carefully and reported the amount consumed.

They ate "high" daily — meat every day, sundaes three times a week; all the lemonade and cookies (special kind) and enriched bread and jelly they wanted between meals — as long as everything was entered in the record book.

The adolescent sextet styled themselves the "Ferric six."

A year from now the scientists will be able to tell the world not only how much iron a healthy 13-year-old requires, but also how she responds to certain levels of calcium and nitrogen.

Yeast From Soil May Build Fat

➤ A YEAST isolated from the soil in the laboratories where the antibiotic, streptomycin, was discovered may help supply fat for livestock feeds.

The yeast was found in New Jersey soil by scientists of the microbiology department of the New Jersey Agricultural Experiment Station at Rutgers University. It can produce large amounts of fatty material which might make it possible to add to short supplies of fat for livestock feeds.

This possibility is now being investigated by an industrial laboratory, Rutgers officials reported. They said the yeast can be grown on various carbohydrates, including glucose, fructose, sucrose, dextrin and starch.

Head-Shrinking Chemical May Be Good Medicine for Cancer Patients

Primitive Drugs of Ecuador

➤ HEADHUNTERS may be bad medicine for their victims but the chemical solution they use for shrinking heads may be good medicine for cancer patients, it was suggested by Dr. Wilburn H. Ferguson, an American-born physician who is on a one-man medical mission for Ecuador.

Cancer is a pathological condition in which the cellular tissue throws off all restraints of growth and multiplies haphazardly. Nothing so far has been found to shrink the cells back to normal once they begin their wild growth. Dr. Ferguson believes that experiments with the super-secret chemical solution used by some Jivaro tribes for head-shrinking may open up a new approach to cancer.

He may be the first white man ever to have obtained this material, which is a closely guarded secret among the Jivaro chiefs. At a press conference held at the Ecuadorean Embassy in Washington recently, he stated that it took him 17 years before he finally found a Brujo, or chief, who would part with a small jarful of it. He is willing to turn it over to competent medical authorities for experimentation, having been promised by the Brujo that a large enough supply would be furnished.

American authorities on ethnology, who have made expeditions to headhunting areas, stated that they were not aware that any super-secret solution was used. The headhunters they came in contact with boiled the heads in water and used the juice from the chinchipe vine for its astringent effect.

However, there are over a hundred tribes in the Amazon basin, each using a different type of solution. Dr. Ferguson was impressed with this process because it not only shrinks normal skin tissue to miniature size but also the cartilaginous tissue in the nose and ear. European pathologists believe that this cannot be done, Dr. Ferguson said.

In all, Dr. Ferguson has brought back some 24 crude drugs used by the Jivaros to treat many conditions. He hopes to interest doctors and researchers in this country in them. He has donated specimens of them to the Museum of the Royal College of Surgeons in Edinburgh, Scotland.

The medical art of the Jivaros has already contributed much to modern medicine. Five widely known drugs, originally used by these people, are quinine, cocaine, caffeine, cascara sagrada and curare, in addition to rotenone which is used as an insecticide.

Some of the drugs brought back by Dr. Ferguson have never been analyzed. Their uses by the natives are: cana agria, used for jaundice; mano de sapo (frog hand), for intestinal colic and dysentery; raibarbudo, for heart failure and palpitation; copal, a disinfectant for open

cuts, tropical ulcers and other sores; guga mama panga, for infections, fevers and other conditions following childbirth.

Dr. Ferguson is here on a mission to interest university medical schools in the establishment of an international teaching hospital for post-graduate students at Quito, Ecuador. He is director of anesthesia at the San Juan de Dios hospital there, which is one of the oldest hospitals on the American continent. It has been in continuous operation since 1565.

Special Museum for Blood Proteins

➤ RESEARCHERS on the proteins of the blood and other body tissues will presently be able to conduct studies in the comparative chemistry of these compounds from many different kinds of animals, at a new, special serological museum now being assembled at Rutgers University, New Brunswick, N. J. It is an outgrowth of studies in systematic serology which have been conducted in the department of zoology here during the past 23 years by Prof. Alan Boyden and his students.

The museum already has blood protein samples, from hundreds of species of animals, contributed by many other institutions. It is expected that more will be received in the near future.

The Rutgers museum is unique among places where zoology is studied. Typically, museums keep only the "innermost insides and the outermost outsides" of animals—that is, their skeletons and their skins, which are relatively easy to prepare and preserve. Here, at least the chemical compounds that keep their life-processes going will be preserved for comparative research.

Celery Controlled by Chemical

➤ BIGGER AND better bunches of early celery are promised through a chemical-control discovery made by a three-man research team at Michigan State College.

One of the worst headaches of the celery raiser has been the tendency of celery plants to "bolt," or send up a flowering stalk, when a chilly night or two stimulated them to do so early in spring. Bolting of course ruins the market ability of celery.

Drs. S. H. Witwer, L. L. Coulter and R. L. Carolus tried spraying test plots of early-planted celery with various concentrations of several growth-control chemicals, at the same time leaving a number of plots untreated, for comparison. Best results were obtained with a long-named chemical: alpha-orthochlorophenoxy-propionic acid.

Treated celery plants uniformly refrained from bolting and developed to marketable size. Of a group of unsprayed plants that had been exposed to chilly night temperatures, 100% had bolted and borne seed by the end of the season.

Similar chemical control may be applicable on other garden plants, like lettuce and radishes, which often ruin their market value by premature bolting.

Show Structures of Compounds With Electron Bombardment

Radical Combinations Revealed

► BEAMS of electrons are being used to bombard organic compounds causing them to give off light which reveals their structure. This is cathode-ray-stimulated spectroscopy. In the New England Spectrochemical Laboratories, Ipswich, Mass., compounds are being studied by this method.

Two men who were formerly astrophysicists are doing the work on cathode ray spectroscopy. They are Dr. Daniel Norman and Dr. William Johnson of the New England Spectrochemical Laboratories. They are working on the determination of molecular structure by studying the light emitted by organic substances, mostly solids, when they are bombarded by cathode rays.

These rays, which are really beams of fast-moving electrons, hit the molecules of the substance, imparting energy to them and knocking off radicals. These molecules and radicals give off energy in the form of light. The light extends all the way from ultraviolet through visible light to infrared, although most of the light studied is in the realm of the ultraviolet. The light given off is then analyzed in the usual manner by a spectroscope.

Use of cathode rays to stimulate the substance under observation to luminescence is particularly useful because the substance can be studied in its solid state. If heat is used to make the substance glow, a solid is usually converted to a liquid or a gas and often decomposed.

Special importance of this method is that it makes it possible to crack an organic material into radicals without disintegrating it further into its component atoms. It is also possible to tell from the spectra the way in which these radicals are assembled. This gives a clue to how the organic substance being analyzed is put together.

Drs. Norman and Johnson are more interested in molecular structure than atomic structure. They are interested particularly in the chemical bonds in organic compounds and in detecting radicals. By studying the form and number of bonds in a substance they are able to determine the degree of polymerization. This is industrially important, for example, in telling the difference between two plastics which have very nearly the same chemical and physical properties. This sort of test may be used in cases of suspected patent infringement.

Spectroscopic tests can also show the degree of curing of a resin-treated fabric, since the curing changes the number and kind of electronic bonds in the material.

An average of 500 pounds of water is sucked from the soil by the roots of plants and passed through the plants to produce one pound, dry weight, of growth.

Neutrons Useful in Analysis

➤ NEUTRONS may provide industry with new eyes for scrutinizing the processing of metals. Researches by T. Ivan Taylor and Prof. W. W. Havens reported at a symposium held by the American Chemical Society's New York Section indicate this possibility.

The conspicuous "appetite" of many of the heavier metals for neutrons traveling at certain speeds serves to identify the metals and to tell accurately in what amounts they are present. This phenomenon, known as resonance absorption, might be applied to measure the thickness of gold, silver, or cadmium plating. An automatic machine could be designed and installed on assembly lines for this purpose.

Another application would be the detection of trace amounts of the metal indium in tin. Although for most purposes impurities of indium would be of little consequence, they might well make tin solder unsuitable for use near cyclotrons, atomic piles, and other sources of neutrons.

The indium would act as a "sink" for neutrons, making the solder itself radioactive and a potential health hazard.

Running checks on the amounts of manganese or cobalt in steel and aluminum could also be made by an instrument emitting neutrons with a velocity particularly attuned to absorption by manganese or cobalt. The applications can be made only if suitable neutron sources become widely available.

Difficult chemical analyses, involving, for example, the hard-to-separate rare earth elements, can be performed simply through observation of neutron absorption.

By a different technique, measurement of the scattering of low speed neutrons, it is possible to determine the amounts of hydrogen remaining when hydrogen is replaced by fluorine in the manufacture of flurocarbon compounds, which promise to be particularly valuable as flameproof construction materials in the future.

Under the auspices of the Atomic Energy Commission, chemists and physicists at Columbia University are determining and listing the effects of neutrons on all the chemical elements, it was reported. The project is under the direction of Profs. Havens, J. R. Dunning, and L. J. Rainwater.

Rats, rabbits and guinea pigs when born are found to have a supply of copper in their livers, but no manganese; during the suckling period the copper is depleted and manganese is acquired from the milk consumed.

Magnesium has an unusual attraction for oxygen; because of this it is highly desirable for flares and incendiary bombs but harder to handle in engineering and construction materials.

Steel parts for airplane engines and other equipment are toughened to double their life expectancy by heat-treatment in ovens containing an inexpensive protective gas made by heating illuminating gas and air together; this prevents decarbonization.

Lightweight Particles Required By Rutherford's Atom Theory

Prediction of the Neutron

A Classic of Chemistry

From Aston's discoveries with a primitive form of the mass spectrograph, Rutherford postulated the structure of the atomic nucleus as a close combination of electrons with hydrogen nuclei. He predicted the discovery of the neutron, of deuterium and of the two particles of mass 3; tritium, an isotope of hydrogen, and He^3, whose production in quantity in the atomic pile has just been announced. To put Rutherford's descriptions into modern phraseology, read "neutron" for each pair consisting of hydrogen nucleus and tightly bound electron, and "proton" for each hydrogen nucleus without the electron. The quotation below is but a part of the lecture.

NUCLEAR CONSTITUTION OF ATOMS, *Bakerian Lecture by Sir E. Rutherford. Proc. Roy. Soc. A97 (1920).*

IN CONSIDERING the possible constitution of the elements, it is natural to suppose that they are built up ultimately of hydrogen nuclei and electrons. On this view the helium nucleus is composed of four hydrogen nuclei and two negative electrons with a resultant charge of two. The fact that the mass of the helium atom 3.997 in terms of oxygen 16 is less than the mass of four hydrogen atoms, viz., 4.032, has been generally supposed to be due to the close interaction of the fields in the nucleus resulting in a smaller electromagnetic mass than the sum of the masses of the individual components.

Sommerfeld has concluded from this fact that the helium nucleus must be a very stable structure which would require intense forces to disrupt it. Such a conclusion is in agreement with experiment, for no evidence has been obtained to show that helium can be disintegrated by the swift *a* particles which are able to disrupt the nuclei of nitrogen and oxygen.

In his recent experiments on the isotopes of ordinary elements, Aston* has shown that within the limit of experimental accuracy the masses of all the isotopes examined are given by whole numbers when oxygen is taken as 16. The only exception is hydrogen, which has a mass 1.008 in agreement with chemical observations. This does not exclude the probability that hydrogen is the ultimate constituent of which nuclei are composed, but indicates that either the grouping of the hydrogen nuclei and electrons is such that the average electromagnetic mass is nearly 1, or, what is more probable, that the secondary units, of which the atom is mainly built up, *e.g.*, helium or its isotope, have a mass given nearly by a whole number when oxygen is 16.

The experimental observations made so far are unable to settle whether the

* Phil. Mag. Dec. 1919; April and May 1920.

new atom has a mass exactly 3, but from analogy with helium we may expect the nucleus of the new atom to consist of three H nuclei and one electron, and to have a mass more nearly 3 than the sum of the individual masses in the free state.

If we are correct in this assumption it seems very likely that one electron can also bind two H nuclei and possibly also one H nucleus. In the one case, this entails the possible existence of an atom nearly 2 carrying one charge, which is to be regarded as an isotope of hydrogen. In the other case, it involves the idea of the possible existence of an atom of mass 1 which has zero nucleus charge.

Such an atomic structure seems by no means impossible. On present views, the neutral hydrogen atom is regarded as a nucleus of unit charge with an electron attached at a distance, and the spectrum of hydrogen is ascribed to the movements of this distant electron. Under some conditions, however, it may be possible for an electron to combine much more closely with the H nucleus, forming a kind of neutral doublet.

Such an atom would have very novel properties. Its external field would be practically zero, except very close to the nucleus, and in consequence it should be able to move freely through matter. Its presence would probably be difficult to detect by the spectroscope, and it may be impossible to contain it in a sealed vessel. On the other hand, it should enter readily the structure of atoms, and may either unite with the nucleus or be disintegrated by its intense field, resulting possibly in the escape of a charged H atom or an electron or both.

If the existence of such atoms be possible, it is to be expected that they may be produced, but probably only in very small numbers, in the electric discharge through hydrogen, where both electrons and H nuclei are present in considerable numbers. It is the intention of the writer to make experiments to test whether any indication of the production of such atoms can be obtained under these conditions.

The existence of such nuclei may not be confined to mass 1 but may be possible for masses 2, 3, or 4, or more, depending on the possibility of combination between the doublets. The existence of such atoms seems almost necessary to explain the building up of the nuclei of heavy elements; for unless we suppose the production of charged particles of very high velocities it is difficult to see how any positively charged particle can reach the nucleus of a heavy atom against its intense repulsive field.

We have seen that so far the nuclei of three light atoms have been recognized experimentally as probable units of atomic structure, viz.,

H_1^+ X_3^{++} He_4^{++}

where the subscript represents the mass of the element.

A mold, Aspergillus niger, is found to be a valuable new test plant because it requires for growth the same minerals as green plants with the exception of calcium, silicon and boron.

The macadamized road takes it name from John Loudon Macadam, a Scottish-born road-building engineer.

Radioactive Isotopes Might Be Used As Portable Power Sources

Packaged Atomic Power

➤ PACKAGED atomic power may prove to be the way that nuclear energy may be applied to jet planes and rockets, flung at long range at an enemy.

Or the glowing "hot" bundles of radiating material, manufactured in the atomic piles as a by-product of bomb material production, may provide concentrated power sources for remote installations for peaceful purposes, such as heat for polar living.

When Atomic Energy Commissioner Lewis L. Strauss stated recently that atomic "storage batteries" might be made, he was referring to the possibility of the artificial production of large amounts of radioactive material by the intense bombardment in the atomic chain reactors at Hanford, Oak Ridge and elsewhere.

The same effect might be accomplished if a dozen pounds or so of pure radium salts were brought together in one place. Mme. Curie saw the radium bromide she produced glow visibly in the dark with its intense radiation. Heat, as well as intense and dangerous gamma and other radiation, is produced by radioactivity, natural as well as artificial.

No one has had or has ever hoped to have pounds of radium, but the atomic piles give the practical possibility of producing by the pound, if needed, a large variety of radioactive isotopes of the chemical elements. More than 600 have already been produced. Of these a score or so might be expected to be useful in the proposed atomic storage batteries.

Most conveniently, these artificially radioactive elements destroy themselves in half-life times ranging from fractions of a second to thousands of years. They literally convert their substance into radiation, and the scientists rate their permanence in the time that is required for half their radioactivity to disappear.

Take sodium, for instance, a common metallic element that is in the sodium chloride of common salt. It has at least three radioactive varieties, created by neutron bombardment, which have half-lives of 23 seconds, 14.8 hours, and three years, respectively.

If this element were the active part of an atomic storage battery, the battery could be charged for a very short time or a relatively long time, depending on which isotope was put in.

The users of such an atomic storage battery could not change its rate of output or vary its length once it was made. This is quite different from the atomic pile itself that depends upon fission of uranium or plutonium by neutrons. The pile can be speeded up or slowed down by the way it is operated, the fastest operation being an atomic bomb that explodes in a fraction of a second. Radioactive decay follows a rate that cannot be changed by similar devices.

Very difficult problems remain before artificial radioactivity can be applied practically for power purposes, just as the methods of applying chain reactors to power production are far from solution. The same protection of human beings and other substances against the lethal and damaging radiations must be achieved, although it might be simpler in some respects for artificial radioactivity.

The conversion of radiation into heat and the transfer of the intense heat and radiation into the kind that can be used practically are major problems, that may take years to solve.

Imagine having an intense energy source in little weight and try to guess what it might mean to rockets and jets, unmanned and radio controlled, aimed at an earthly or even a moon target.

Agene to be Abandoned for Flour

➤ FLOUR for the staff of life, and for macaroni, noodles and pastry as well as bread and biscuits, will soon be freed from the danger of causing fits, in man or dog.

A U. S. Food and Drug Administration order for a change from the potentially dangerous "agene," or nitrogen trichloride, to chlorine dioxide for treating flour from certain kinds of wheat is to be issued soon.

Sir Edward Mellanby, distinguished English nutritionist who just two years ago discovered the possible danger of agenized flour and bread, came over from London to give a first-hand report of his findings at the Food and Drug Administration hearings.

"Running fits," or canine hysteria, he found, was produced in dogs by feeding them flour treated with nitrogen trichloride. This chemical has been widely used for the past 25 years to age flour from certain kinds of wheat so it will make better bread.

The possibility that the agenized flour might be causing epilepsy or some kind of nervous disorder in humans alarmed everyone, medical and health scientists as well as the general public.

No hint of any damage to humans from this flour had come in all the 25 years it has been used. Special studies were made in which the agenized flour was fed human volunteers in amounts and for periods of time that would unfailingly produce "running fits" in dogs. No symptoms and no changes in brain waves, suggesting a tendency to convulsions or fits, were found.

Nevertheless, our Food and Drug Administration, the flour millers of the nation, and manufacturers of "agene," decided to play it safe. So instead of nitrogen trichloride, flour in future will be treated with chlorine dioxide. So far as can be found by scientific studies, this chemical has no harmful effect on humans or dogs or other animals.

Technically, the Food and Drug order for such a change comes in the form of an announcement of an amended standard for flour.

Corrosion Prevention Methods Save Costly Damage to Metal

Electro-Chemical Corrosion

➤ COATINGS necessary to protect underground metal pipe lines from corrosion have become a major item in the total cost of a new line, the American Petroleum Institute was told at a meeting in Chicago by L. F. Scherer, of the Texas Pipe Line Company, and O. C. Mudd, Shell Pipe Line Corporation.

No practical pipe insulating material has been found which will stay completely stable and moisture-proof in the soil over an extended period, they said. The economical alternative is to apply one which will remain reasonably stable under soil pressure and has a low moisture absorption rate, and to compensate for its imperfections by applying cathodic (electrical) protection.

In recent years industry has generally concluded that coating protection of some form should be provided on new pipe line installations. All corrosion is electro-chemical action, they stated. The soils in which most metal structures are buried contain moisture or water with dissolved natural chemicals. Corrosion of metals by contact with soil proceeds only in the presence of moisture. It can be prevented by insulating the metal from the moist soil or by nullifying the latter's electrolytic action. In cathodic protection, the electric currents decompose any moisture that reaches the face of the pipe into gaseous components which escape through the coating flaws.

Various types of coatings were reviewed by the scientists. Included were asphalt and coal tar in solvents, asphalt emulsions, asphalt enamel, petroleum-base or grease-type materials, asphalt mastics, coal-tar enamel, and others. Results of experimental tests with all these were summarized.

The evidence showed that a single flood-coat of coal-tar enamel, machine-applied, when supplemented with cathodic protection, gave best results with respect to cost. It also showed that much coating damage is caused by poor trench preparation before lowering pipe and by carelessness in lowering and back-filling. A bed of fine-textured soil or sand should be spread in the trench bottom before lowering the pipe to give uniform weight distribution, and fine soil should be used for the first back-fill.

Corrosive Antifreezes

➤ SALT-BASE antifreezes in the radiator of your car can ruin its cooling and ignition systems, National Bureau of Standards scientists have found in new tests.

A complete series of engine tests by Bureau scientists, Donald B. Brooks and Ronald E. Streets, revealed that salt-base antifreezes are likely to corrode engines, necessitating replacements of radiators, water pumps, and cylinder heads. Products of the corrosion will clog up water passages in the radiator, causing overheating and boiling. No known inhibitor can prevent their corrosive action, the scien-

tists state in a newly-published Bureau circular.

Recommended for automotive antifreeze use are the alcohols and the glycols. Petroleum-base antifreezes should be used only if your car is equipped with certain types of synthetic radiator hose. These antifreezes will attack natural or reclaimed rubber.

The safest antifreezes, simple alcohols and glycols, will not corrode engine parts. Tap water with which they are mixed does have a corrosive effect, however. For this reason most antifreezes contain a corrosion inhibitor which lasts during one season's use.

The alcohols—methyl, ethyl, and isopropyl—are alike in having low boiling points in comparison with water. They must be replaced from time to time, especially during mild weather.

Ethylene glycol and a newcomer, propylene glycol, boil at higher temperatures than water, and are therefore "permanent" antifreezes, remaining in the radiator when the water boils off.

Harmful salt-base antifreezes have practically no fire hazard; the glycols are also considered safe in that respect. Simple alcohols and petroleum-base antifreezes may ignite in case a spark reaches them, but the scientists add, the problem of automobile fires is a secondary one.

Tiny Impurities in Metal Weighed

➤ IMPURITIES in a metal, as little as one part in a million, are detected and weighed by an electronic device revealed by Westinghouse Research Laboratories. It does in from five to 15 minutes a job for which days are required by chemical methods.

The detector is an adaptation of what is known as a mass spectrometer, an electronic tube which sorts out materials in mixtures according to their atomic weight. William M. Hickam, Westinghouse physicist credited with its development, says it spots an impurity by weighing it. The tell-tale weight of its atoms gives it away.

A tiny but powerful furnace, an electron beam and a curved metal tube are the main elements of the device. In use, the instrument is set so that it records only the presence of an impurity with a specific weight.

The furnace is used to vaporize a tiny sample of the metal of known weight. The atoms that boil off enter a cube-shaped enclosure where they are bombarded with electrons from the electron beam. This bombardment knocks off particles from the atoms and thus leaves them electrically charged. These are sent careening down the metal tube at a rate of a million feet a second. The tube is fixed between the poles of a powerful electromagnet.

As the atoms speed down the tube, the electromagnet "pulls" at them in such a way that only those having a certain mass, or weight, complete the path around the tube and pass through a tiny slit in a metal target at the end. Atoms weighing more or less than those hitting the target do not get around the bend.

Aches From Copper Lack

➤ CATTLE fed on diets deficient in copper develop a disease resembling human arthritis, Dr. George K. Davis of the University of Florida Agricultural Experiment Station, Gainesville, reported to the American Chemical Society.

In severely copper-deficient areas of Florida, changes which occur in the bone metabolism of cattle are striking.

With a copper content of less than four parts per million in the forage, calves develop a severe malformation of the bones similar to the low phosphorus rickets seen in other species. This is true even with adequate phosphorus and calcium in the feed and with plenty of sunlight.

The principal breakdown occurs in the area of new bone formation. Enlargement of the ends of the leg bones, beading of the ribs and a generally poor condition are all symptoms of rickets. There is also a rapid increase in blood phosphatase, a body chemical which promotes the use of energy foods.

Response to copper therapy, in the form of the administration of copper sulphate, has been particularly rapid in the calves. The blood phosphatase values return to normal, bone calcification proceeds normally and the enlarged ends of bones soon resume normal proportions.

In older animals, bones become fragile and rarefied, resulting in a frequent joint erosion which may cause inflammation and great pain. In many respects this condition resembles arthritis in humans. It may also result in an abnormal and painful gait commonly called "paces," because of its similarity to the gait of a pacing horse.

Radioactivity Proves Sugar Formation

➤ RADIOACTIVE carbon from Oak Ridge was used in producing definite proof that green leaves can add together the two simple sugars, glucose and frutose, to form cane sugar or sucrose, by Dr. Constance Hartt, research plant physiologist of the Hawaiian Sugar Planters' Association.

It had long been known that if cut leaves are placed in glucose-fructose solution in the dark, there is an increase in the amount of cane sugar they contain. However, until now it had not been conclusively demonstrated that the simple sugars actually entered the leaves and became changed into cane sugar.

Dr. Hartt first made radioactive glucose and fructose by "feeding" radioactive carbon dioxide to sugarcane leaves in the sunlight, and then chemically converting the sugar thus produced into the form needed for the experiment. Then these radioactive sugars were supplied in solution to other cane leaves in darkness, with all exchanges of material checked by accurate quantitative methods.

The new cane sugar formed in the leaves was radioactive. The only possible source of radioactivity was the glucose-fructose solution.

Petroleum Problems Shared At Recent Technical Sessions

Advances in Oil Chemistry

➤ SOUR CRUDE OIL is a headache to the oil industry, judging from technical papers presented at the recent meeting of the American Petroleum Institute. Sour crude oil is that way when it comes from the earth. It is oil that contains hydrogen sulfide and other sulfur compounds. It eats the tanks that store it and the pipelines that carry it to refineries.

West Texas is the area from which the greatest volume of sour oil comes, the Institute was told by R. A. Brannon of the Humble Pipe Line Company, Houston. It is, of course, produced from many wells in other sections. These sour oils are corrosive to tanks in varying degree, depending upon the amount of sulfur and sulfur compounds, as well as the amount of other dissolved or suspended matter in the oil, such as salt water, iron sulfide, and other substances.

Most of the corrosion damage occurs on tank bottoms where salt water settles, and in the vapor spaces where moisture condenses. Reasonably satisfactory protective coatings have been developed for tank bottoms in the form of bituminous matter which is usually applied in the molten state.

Pipe Line Corrosion

There are four principal ways by which hydrogen sulfide from crude oil attacks steel pipe lines, the Institute was told by Lyle R. Sheppard of the Shell Pipe Line Corp., Houston. Sometimes there is a direct chemical action of the sulfide with the iron, and again the sulfide may oxidize to free sulfur which unites chemically with the iron.

Iron sulfides from these two actions form galvanic cells with iron in the presence of brine. Also there may be a creation of hydrogen-sulfide concentration cells which accelerate the sulfide or sulfur combination with iron. In all these mechanisms hydrogen is liberated during the formation of the iron compounds. Mr. Sheppard discussed methods of corrosion detection and methods of prevention.

Improved Seismic Method

➤ AN IMPROVED method of locating probable underground petroleum deposits by the so-called seismic method was revealed by the Institute of Inventive Research. It is the work of Dr. Thomas C. Poulter, and utilizes "shaped charges" of explosive compositions which are set off above the ground, thus eliminating the cost of drilling shot holes.

Shaped charges go back to what physicists know as the "Munroe effect" which was announced to the world in 1888 by Prof. Charles E. Munroe. He found that if a hollow is made in an explosive cartridge on the side toward the object to be blasted, the effect of the blast is greatly increased. The hole can be conical or hemispherical in shape. The principle was well applied during the war in the bazooka rocket, which was far more effective in piercing armor plate than are bullets.

In the seismic method of locating

probable oil deposits under the earth, a seismograph similar to that used in observatories to record earthquake tremors is employed. But the tremors are man-made, and are rather minor. An explosive is detonated in a drill hole, the depth of which varies in different locations. Shock waves travelling downward deep into the earth are reflected back by the rock structures encountered. Experts, from a study of the recordings made by these reflected shock waves, are able to determine underground layers favorable to petroleum deposits.

Dr. Poulter's new method will provide economy in eliminating the need of boring holes, and it can be used in regions where boring would be exceedingly difficult, as in isolated mountainous country or in a search for oil under the sea. Dr. Poulter, who is associate director of Stanford Research Institute of Palo Alto, Calif., has tested his method against conventional procedures in various locations.

In his procedure, the charges in the explosive pattern are set on stakes relatively close to the ground and spread in a hexagonal design. Depending upon the type of records sought, comparatively light charges are placed from five to 85 feet apart and detonated simultaneously. The method may be used to produce an essentially flat wave front of low amplitude over a relatively large area.

Under Continental Shelf

➤ LARGE PETROLEUM accumulations exist under the American continental shelf and it is physically possible to get the oil from them, the American Petroleum Institute was told by Mercer H. Parks and James C. Posgate of the Humble Oil and Refining Company.

Continental shelf petroleum production has passed the initial planning stage and as a result of successful drilling operations, at least two oil discoveries of possible major importance have been made, both in the Gulf of Mexico.

Operations in open water encounter problems of the elements in addition to those usual on land. Auxiliary operations, such as transportation and drilling site preparation, become major items from technical and financial viewpoints.

The drilling sites now in use involve large platforms capable of supporting everything needed for drilling operations, as well as smaller platforms serviced by floating barges in a manner similar to that used in sheltered waters.

The two oil discoveries of possible major importance are a producing well off Terrebonne Parish, La., of Kerr-McGee Oil Industries, Inc., and one drilled by the Humble Company off Jefferson Parish, La.

The first is a very shallow well, producing from a supercap sand through perforations about 1,750 feet deep. The Humble discovery came at a depth of about 8,650 feet in a second well drilled in the area. Until other wells are drilled, no proper evaluation can be made of the discovery, but the prospect is promising.

As generally understood, a continental shelf is the land mass lying submerged off the coast in less than some 600 feet of water. The United States continental shelf covers 750,000 square miles, of which 129,000 are in the Gulf of Mexico. This strip averages about 75 miles in width. It is in the Gulf shelf that oil men expect to find the best oil reserves.

Million Barrels Daily

➤ SYNTHETIC OIL from coal, to the tune of 1,000,000 barrels daily, was given as the objective of a program outlined to the American Society of Mechanical Engineers by J. D. Doherty of the U.S. Bureau of Mines. The cost of production, he said, should be approximately 12.5 cents per gallon.

Describing work in research and development already under way by the Bureau of Mines and others in the production of synthetic oil, he called attention to the need for prompt erection of at least some commercial plants because synthetic liquid fuels are not going to do us much good in an emergency if we have to start from scratch.

A completely new and detailed estimate of the coal reserves of the United States is being made by the U.S. Geological Survey, the engineers were told by Paul Averitt of the Survey staff. It will take 10 years to complete.

The coal fields of the United States are large in all dimensions. They cover roughly 350,000 square miles, or approximately one-ninth of the total area of the nation. The coal-bearing rocks commonly are several thousand feet thick and, as in West Virginia, contain as many as 117 named and correlated coal beds.

House Gas From Cheap Oil

➤ HOUSEHOLD GAS from low-cost oil can be made by a new economical process, according to the American Gas Association. The process utilizes troublesome coke deposits in present methods as fuel for heat to gasify heavy oil.

Present oil gas processes are unable to use the cheaper, heavier oils successfully because their large carbon content forms excessive quantities of petroleum coke within the gas generator. This makes it necessary to remove the generator from service from time to time, so that the equipment can be purged with air currents to burn out the coke.

In the new process, an invention by Edwin L. Hall, director of the American Gas Association laboratories at Cleveland, Ohio, the coke deposit is burned off during the gas-making period and supplies a good portion of the heat necessary for gasifying the heavy oil without requiring any additional time.

The process, tested for a year in a commercial installation, makes possible a reduction of 30 per cent or more in the cost of gas-making materials, the association states, and an increase of about 35 per cent in thermal capacity of existing gas-making apparatus.

A special medical committee has been appointed by the Swedish government to study the ill effects resulting from the use of wood and charcoal producer gas units in motor vehicles; the gas is a substitute for gasoline.

Polaroid goggles with eight-inch window-like plastic lenses protect the eyes of aircraft combat men; their flexible frame fits the face and cuts out side light and danger from flying fragments and flames.

Analysis Method for Uranium

➤ VERY SMALL amounts of the atomic energy atom, uranium, can be detected by a new method of spectral analysis reported to the Optical Society of America by Dr. L. T. Steadman of the University of Rochester.

Expected to be of use in measuring uranium present in many sorts of materials, the sample is burned in the crater of an electric carbon arc and the light given off is split into its spectrum lines by a quartz spectroscope. The brightness of the uranium lines measured shows the amount of the metal present.

Crops Increased by Chemicals

➤ CORN and other vegetable crops are being increased 19 to 66 per cent by two non-poisonous chemicals which guard against plant diseases and seed rot.

Dr. D. Lorin Schoene of United States Rubber Company told the American Chemical Society that final field trials of the chemicals, called quinones, proved them to be the most successful seed protectants and crop disease preventives yet discovered.

Less than a penny's worth of the seed protectant per acre of corn had increased crop yield in Iowa 36 per cent. For five to six cents per acre, peanut crops in Virginia have been increased in stand over 66 per cent. Similar results, he stated, have been obtained with lima beans, sugar beets, peas, sweet potatoes and sorghum.

Apple scab and bitter rot are practically eliminated by a quinone type spray at a cost of nine cents per tree per spraying. The spray also controls brown rot of peaches, potato and tomato blights, anthracnose of beans, cherry leaf spot, black spot of roses, azalea petal blight and other fungus diseases.

Dr. Schoene said the two chemicals, developed in his company's laboratories in Naugatuck and Bethany, Conn., are known as Spergon, a seed protectant, and Phygon, which is both a seed protectant and fungicidal spray for foliage and fruit. Either may be mixed with DDT for added protection of stored seed against insects.

The seed protectant acts by killing fungi on the seed and in the soil which cause rotting of seeds and sprouts. The sprays protect against the airborne spores of fungus diseases. Both chemicals are harmless to animals and humans. Treated corn seed has been fed to hogs with no noticeable ill effects.

Aluminum and magnesium look so much alike that the layman can hardly tell them apart, but the magnesium is one-third lighter than the aluminum.

Syria and Lebanon in 1943 produced nearly 1,500,000 pounds of silk cocoons.

Sugar and Soap Aid Tire Rubber

➤ SUGAR AND soap are helping make better automobile tires. They are used in a so-called redox process in which synthetic rubber may be manufactured at a freezing temperature, according to Prof. Carl Shipp Marvel of the University of Illinois.

The quality of GR-S, the synthetic rubber blended with natural rubber in all tire treads, has been greatly improved by the recent development of the amazingly rapid redox process. This new method makes it possible to manufacture rubber at freezing or sub-freezing temperatures instead of at 212 degrees Fahrenheit, the conventional temperature.

The quality of GR-S and similar rubbers seems to go up as the temperature goes down. GR-S is essentially a combination of two petroleum compounds, butadiene and styrene, which are made to unite or polymerize by a chemical stimulant, or catalyst. In the redox process, the compounds are first emulsified with a soap, and the reaction is started by a type of sugar, called the activator.

New Material for Supersonic Planes

➤ A SPECIAL lightweight "sandwich" material has been developed for manufacturing supersonic aircraft, to protect them against the vibration and heat of their terrific velocity, facilitate their construction and even increase their speed.

The bread in this new combination of materials can be a thin layer of plywood, metal or plastic laminate, Norman E. Wahl, head of the wood and plastics section of the Cornell Aeronautical Laboratory, Buffalo, N. Y., told the American Chemical Society's division of paint, varnish and plastics chemistry.

The synthetic adhesive holding the core material to the sandwich faces can be likened to butter. The meat, or core of the sandwich, consists of a lightweight foamed plastic, rubber, balsa wood, or a cellular honeycomb substance.

The new material gives supersonic planes a smooth exterior skin by eliminating rivets and laps, and tests have proved that speeds can be increased as much as fifty miles an hour by a smooth outer surface. It affords greater efficiency owing to its high buckling strength, its ability to withstand vibration and its excellent insulating properties against heat and noise.

Whole sections can be molded in one operation, saving time.

Fiberglas laminate in sandwich construction is necessary for radar housings, since metal destroys radar waves. During the war rainstorms eroded the plastic housings for radar scanning antennae then in use. The rain erosion appeared similar to abrasions caused by severe sand blasting. In some cases it wore off all the plastic antenna housing and reduced plane speeds ten to fifteen miles an hour.

Accident Prevention Courses As Part of Chemistry Training

Safety Urged in Chemistry Lab

COLLEGE chemistry text-books and laboratory manuals will include information on accident and health hazards as the result of a safety campaign. Howard Fawcett of New Castle, Del., a member of the national safety council of Alpha Chi Sigma, professional chemical fraternity, has outlined a comprehensive program of safety education to the American Chemical Society's division of chemical education.

"The safe and efficient operation of chemical enterprise is becoming more and more imperative, because it is an economic as well as a humanitarian problem," Mr. Fawcett said. "Unless technical students are given the proper introductory training and perspective in safe practices, supplementing academic training, the transition from college to the commercial laboratory frequently is both difficult and dangerous."

Accident prevention, fire protection, first aid, toxicity of chemicals, and industrial hygiene are among the topics emphasized in the safety campaign which is being conducted by forty-four collegiate chapters of the fraternity in leading chemistry and chemical engineering schools.

Among the specific projects are:

A complete survey of laboratories with recommendations for correction of unsafe conditions submitted in a report to those in authority and followed up until corrected.

Clean-up drives in laboratories.

Publicizing of often-fatal consequences of experiments with explosive compounds by unqualified persons and youngsters.

Demonstrations and practice in use of fire extinguishers, gas masks, emergency showers, fire blankets and artificial respiration.

A "Safety Night" in which off-campus speakers discuss safe practices in chemical and engineering laboratories.

Publication of accident abstracts and appropriate articles in fraternity magazines.

Printing of safety posters, four of which are now being distributed.

If the total span of life on earth is plotted on a 24-hour clock, where one minute equals 1,660,000 years, historic man has been on the earth only half a second; fishes for over three and one-half hours.

Plastic foam, lighter in weight and lower in heat conductivity than cork, rock wool or glass, has been recently developed; in its manufacture a molasses-like mixture foams without heat to 30 times its volume.

Bacitracin Available

➤ BACITRACIN, the antibiotic discovered in 1945, is now available commercially, but you will need a physician's prescription to get it.

The drug has proved effective in the treatment of many skin and local surgical infections, such as boils and abscesses, often making surgery unnecessary. It also checks the growth of many gram-positive streptococci and staphylococci, as well as the pneumococcus, gonococcus, meningococcus and the spirochete of syphilis.

It was isolated by Dr. Frank L. Meleney of the Columbia College of Physicians and Surgeons from the infected wound of a patient.

Ground Rock Is Fertilizer

➤ SOIL conservation is being aided by the rapidly increasing use of finely ground rock phosphate for direct application as fertilizer.

Rock phosphate will supplement, rather than replace, the more expensive chemically treated product called superphosphate, it was emphasized in a paper presented to the American Chemical Society by Thomas R. Cox of the Agricultural Chemicals Division of the American Cyanamid Company, New York, and M. V. Bailey, director of the company's agricultural research. The net effect of the new trend will be to increase the total amount of phosphorus restored to the land through fertilization.

In the past few years, direct use of rock phosphate has become so widespread that it is estimated that one-eighth of the entire current output of rock phosphate for fertilizer is being employed in this manner.

A shipment in August of a fifty-one-car train of 2,100 tons of rock phosphate to Jersey County, Ill., is believed to be the largest single shipment yet to any one county. The entire tonnage has been ordered by 250 farmers. Half of them had never previously used rock phosphate but were sold on the need for it when soil tests showed that 70 per cent of the soils in the county needed phosphorus.

It was recently said that "we are at the place in phosphate needs that we were twenty to twenty-five years ago with regard to lime."

Despite the increase in the direct application of rock phosphate, finely ground rock phosphate is not a substitute for superphosphate. Both substances are considered a team and used to supplement each other, depending on soil conditions and cropping systems involved. Finely ground rock phosphate is not generally recommended unless legumes and sod crops occupy the soil a good part of the time.

The acreage planted to carrots in the United States has increased sevenfold since nutrition specialists started pointing out the value of this vegetable in the human diet.

New Fibers and Dyes Studied for Permanence

Textile Makers Stress Serviceability

➤ STYLE and color in a fabric today are, without question, of prime importance. But the war has taught everyone that in yard goods other things are equally as important as surface appearance, Weldon G. Helmus of Fair Lawn Finishing Company of Fair Lawn, N. J., told members of the American Association of Textile Chemists and Colorists at a recent meeting.

The customer would like to know just what he can expect in a purchased garment, Mr. Helmus stated. He asks himself such questions as:

"Can it be worn in sunlight, or would it be better for evening wear?

"Can it be hung in a closet without fear of fading?

"Will a raincoat actually withstand rain, or would a heavy fog penetrate it?

"Will my bathing suit withstand the effects of chlorine and salt water?

"Will the results of cleaning give my young son a new wardrobe?

"After the expense of providing the 'new look' for the female members of my family, will the cleaner return to them the 'old look' with an added blow to the budget?"

More and more thought is given today, Mr. Helmus stated, to the final use of the fabric. Thus serviceability has gradually been improved. The more conscious we become of these end uses, the better will be the quality and the happier the consumer.

New and improved synthetic fibers have given impetus to the development of better methods for processing them. Chemical and dye-stuff companies have brought out new materials. Machinery manufacturers and instrument makers have simplified designs. Weavers have set up their own quality control departments. Progressive dyers and finishers, utilizing these contributions and adding innovations of their own, today produce merchandise of improved quality.

In dyeing and finishing, the importance of scouring cannot be overemphasized. It makes little difference where the dirt comes from, its presence results in inferior quality. By proper manipulation it is possible to change completely the final appearance of the cloth at this point.

There is no substitute for a good washing job after scouring, Mr. Helmus pointed out. Plenty of soft water to remove any residual dirt or chemical will pay dividends in subsequent treatments. Any dyeing and finishing plants that do not have good washing facilities, and a sufficient supply of soft water which they can afford to waste, better look for a new plant site. It would be cheaper in the long run.

Just as the colors extracted from shrubs and roots varied in fastness, so the new coal tar dyes also vary in

their performance. No dye is fast to everything. With the proper selection, however, it is possible to apply color that will last almost as long as the fabric.

One of the greatest problems with most resins used in finishing piece goods is that they retain chlorine. This is particularly true on whites, where the average laundry uses chlorine in its operation. Resins that retain chlorine are detrimental to fabrics in the long run because of the release of acids when they dry. This hurts the tensile strength and usually gives a yellowish appearance to the fabric.

Basic Chemicals From Wood

➤ Wood may someday replace coal and petroleum as a source of basic chemicals, according to Dr. Irving A. Pearl, of the Institute of Paper Chemistry, Appleton, Wis. Greater use of wood, which is a renewable resource, would prove particularly valuable as a conservation measure.

Many by-products obtained in the processing of wood could be put to work instead of being wasted.

Wood alcohol, turpentine and pitch are chemicals extracted from wood. Lignin, a waste product of the pulp industry, is an important potential source of chemicals.

In lignin we have a raw material that potentially can rival coal tar or petroleum as a source of synthetic organic chemicals, the chemist declared.

Chemical Helps Insecticides Stick

➤ A chemical used during the war to make mustard gas has been adapted to a peacetime role in protecting crops.

Raymond C. Crippen and Leonard Buchoff of Penniman & Browne, Baltimore, told the American Chemical Society that they have also found other uses for the chemical thiodiglycol in the manufacture of resins, plastics, oils and gasoline.

"Sticking" agents were prepared from thiodiglycol for insecticides and fungicides which mix with water and then stick longer where they are sprayed to protect crops.

Thiodiglycol is similar to a combination of ethylene glycol and sulfur. It is a thick, water-soluble, amber fluid which does not boil under 330 degrees Fahrenheit, and also gives protection against freezing down to 10 degrees Fahrenheit. There are large quantities of the compound available in storage.

Another chemical used during the war now is being used as a fertilizer for seedlings and as a feed supplement. It is green manganous oxide which is employed as a flux in welding light metals. Other uses which have been discovered for this oxide are as an ingredient in welding rod castings, as a "trigger" for organic reactions, as a primer pigment for paints, and as a paint drier.

It was found especially adaptable in agriculture, since it dissolves slowly in the soil and does not produce toxic concentrations.

Patents Reveal Processes Using Chemical Methods

Patents on Chemical Products

Write the Commissioner of Patents, Washington 25, D. C. to obtain a copy of complete specifications of any patent, ordering by number and enclosing 25 cents for each one ordered. Do not send stamps.

➤ SIMPLE SUGARS, fermentable into industrial alcohol and other useful products, can be made from the cellulose in corncobs, oat hulls, straw, sugarcane bagasse and other farm wastes by a process on which U. S. patent 2,450,586 has been granted to two U. S. Department of Agriculture scientists, Drs. John W. Dunning and Elbert C. Lathrop of the Northern Regional Research Laboratory at Peoria, Ill.

Wood sugar and-related compounds containing only five atoms of carbon per molecule are first obtained by treating the cellulosic material with dilute sulfuric acid. The residue is quickly dried in a current of warm air, ground up fine, and converted into a slurry or thin paste. This is treated with a warm solution of sulfuric acid, at from 7% to 9% concentration, under pressures of from five to 45 pounds per square inch. This converts the cellulose into dextrose, which emerges as a 10% sirupy solution. This is treated with lime to neutralize the remaining acid, and is then ready "as is" for fermentation.

Hormones Check Scald

➤ ANOTHER Department of Agriculture scientist, Harold A. Schomer of the great research station at Beltsville, Md., has received patent 2,450,615 on a way to prevent the injury known as "scald" in stored apples and other fruits. The fruit is dipped in an emulsion made by mixing alpha naphthalene acetic acid, indole butyric acid or other synthetic growth-control chemical with lanolin and suspending this in water at relatively low concentrations. Mr. Schomer states that spoilage of stored fruit so treated is very low, as compared with that in untreated control lots.

Rights in both the foregoing patents are assigned royalty-free to the government.

Ca Helps Mirror-making

➤ MAKING OF special mirrors and other fine evaporation-coating jobs are helped by calcium and related elements serving as go-betweens in ironing out the incompatibility between the tungsten or tantalum heating coil and the gold, silver, copper and other coating metals. Left to themselves, these metals refuse to wet the coil when melted, but just drop off. However, William H. Colbert and Arthur R. Weinrich, both of Brackenridge, Pa., have found that by putting a little calcium into the coating metal they can get it to spread out nicely over the heating coil, whence it is evaporated and so reaches the surface to be coated.

No less than eight patents, Nos. 2,450,850 through 2,450,857, have

been issued on this process. Rights are assigned to the Libbey-Owens-Ford Glass Company.

Vitamin for Chicks

➤ TWO RESEARCH chemists working in the Detroit laboratories of Parke, Davis and Company, Orson D. Bird and Stephen B. Binkley, have discovered an improved method for extracting from alfalfa, yeast and other plant sources a potent vitamin for the prevention of chick anemia. Patent 2,450,710 has been granted on their process.

Slipprier Spaghetti

➤ SPAGHETTI strings are made more cohesive (and presumably more glutinous and slippery as well) by the addition of a combination of the three "jellifying" materials, pectin, algin and gelatin, in the invention on which Rene Samson of Montreal has received patent 2,450,525.

Metal Solder

➤ A SOLDER for aluminum and similar metals, compounded by Henri M. Boonen of Houma, La., for patent 2,450,778, contains manganese, aluminum, magnesium, copper, bismuth, zinc and tin.

New Insecticides

➤ A GROUP of insecticides, claimed to be especially useful against aphids, red spider and other hard-to-kill plant pests, is the subject of patent 2,451,085, granted to two research chemists of Rohm and Haas Company, Drs. W. F. Hester and W. E. Craig. Basis of the new compounds is a complex organic chemical, caprylphenoxyacetic acid. To this are attached various atom chains of the type known as alkylenes, plus an atom of chlorine, bromine or iodine or a cyanogen group. Curiously enough, although the acid "backbone" of this group is chemically related to some of the newer plant-killing substances, the insecticides covered by the present patent are declared harmless to plants.

Two Glass Fiber Patents

➤ A NEW METHOD for coloring hard-to-dye glass fabrics has been developed, for patent 2,450,902, by Dr. Carl M. Marberg of the Interchemical Corporation, New York City. He coats the fibers with a vinyl polymer solution containing the desired pigments.

Glass fibers are used for fireproof sound-proofing in the invention on which patent 2,450,911 was granted to A. D. Park and N. A. Johnson of Lancaster, Pa., assignors to the Armstrong Cork Company. A loosely packed base of the fibers is covered with a more closely-fabricated face layer of the same material.

Aluminum Extraction

➤ ALUMINUM can be extracted from its common ore, bauxite, more readily and cheaply and also despite the presence of higher concentrations of iron, silicon and other impurities, it is claimed on behalf of a process on which U. S. patent No. 2,451,490 has been granted to Arthur F. Johnson of Cambridge, Mass., assignor to the Reynolds Metals Company.

In aluminum refining as usually practiced, impurities that would interfere with the Hall method of electrolysis are eliminated by treating the bauxite with a hot caustic soda solution, then crystallizing out alumina at a high purity level. In the new process, the raw bauxite is instead first smelted in a furnace with coke

and a flux appropriate to the impurity to be removed. The purified product, still molten, is then fed into the molten cryolite in the electrolytic cells, thus saving the current that would be needed to heat it up. The electrolysis is also considerably changed from the time-honored Hall method.

Phosphor Materials

➤ Among other chemicals and processes recently patented are phosphor materials, for which Ferd E. Williams, Princeton, N.J., received patent 2,447,447; a silica-magnesia catalyst, for which patent 2,447,181 was awarded Darrel J. Butterbaugh, Abington, and Le Roy U. Spence, Elkins Park, Pa.; a method of refining polymerized rosin which brought Burt L. Hampton, Jacksonville, Fla., patent 2,447,009; and infrared-responsive phosphors, patent 2,447,322, received by Gorton R. Fonda, Schenectady, N.Y.

These have all been assigned: the first to Radio Corporation of America, Camden, N.J.; the second to Rohm and Haas, Philadelphia, the third to the Glidden Company of Cleveland, Ohio, and the last to the General Electric Company, Schenectady, N.Y. Mr. Williams' phosphor materials contain zinc fluoride, a fluoride of calcium, strontium or barium, and a manganese activator. The silica-magnesia catalyst is for use in conversion of ethanol to butadiene at elevated temperatures.

Dirty Oil Re-cleaned

➤ For a way of removing water, acids, volatile fractions, etc., from dirty used lubricating oil, Charles J. Egger and Robert H. Webster of Cleveland have received patent 2,451,688. It consists essentially in projecting the oil as a fine spray into a closed heated chamber at less than atmospheric pressure. This evaporates the lighter impurities into vapors, which are drawn off and condensed for what salvage value they may have. Carbon, metal dust and other solid dirt is removed by filtration.

K-Ration Fruit Bar

➤ Too late for millions of World War II GI's, scientists at the University of California College of Agriculture have gone to work on making a better tasting version of the dried fruit bar in the Army's K-ration. They added chopped toasted almonds and honey or corn syrup. The result is said to be a 100% more tasty bar.

GI fruit bars were about half raisins, with prunes, apples, figs, apricots and a little ground candied orange peel for flavoring. Dr. W. V. Cruess and students John Brekke and Henry Seagrave-Smith have developed this new recipe: 20 parts Muscat raisins; 20 parts Calimyrna figs; 20 parts chopped toasted almonds; 20 parts honey or corn syrup; 15 parts dried apricots; and five parts candied orange peel.

They say that any housewife can make the bar by grinding the fruit, adding the nuts and mixing well. When cut into bars, the candy should be rolled in chopped coconut.

Limited quantities of American penicillin have been sent to the Swedish government for use by its health authorities.

➤ A STRING *of Nasen bottles, such as this being lowered from the yacht, the E. W. Scripps, of the Scripps Institution of Oceanography, is used to obtain samples of sea water at different depths.*

Sampling Devices Yield Data Solving Mysteries of the Sea

Analyzing the Ocean

by Martha G. Morrow

▶ Davy Jones is beginning to tell some of his secrets. For instance, scientists recently have learned that:

The Gulf Stream, considerably narrower and swifter than previously supposed, meanders like a great river.

Soft, unconsolidated sediment, 3,000 feet thick in places, has been found to overlie the solid floor of the ocean in some regions.

Giant undersea waves, up to 650 feet high, exist in the ocean, but move slower than surface waves.

Surface waves can travel so fast they sometimes outrun the wind that is pushing them along.

And here are deep-sea long shots that may some day pay off:

Discovery of new oil fields through knowledge of the process by which petroleum is formed.

Long-range weather forecasting for coastal regions through studies of ocean currents.

Physicists, biologists, geologists and chemists making the ocean their specialty must be a particularly hardy sort. They spend many months at sea; their laboratory is a tossing, pitching vessel. Then follow years of research, during which the data and samples gathered at sea are examined and analyzed.

The auxiliary ketch Atlantis is the pride of the privately-endowed Woods Hole Oceanographic Institution at Woods Hole, Mass. Recently a hitherto uncharted mountain rising 6,000 feet above the ocean floor east of Bermuda was discovered by scientists sailing the Atlantic in this ship, one of a fleet of eight boats belonging to the institution.

The chief floating laboratory of the Scripps Institution of Oceanography of the University of California at La Jolla, Calif., is the E. W. Scripps, formerly a movie star's luxury yacht. Three additional vessels are being equipped to supplement this craft; two are ex-Navy vessels, one a former fishing boat.

Cruising the Pacific Ocean, the E. W. Scripps has been instrumental in exploring deeply-submerged mountain peaks and ocean-covered canyons with sheer rock walls a mile or so high. One of these, off Monterey, Calif., is larger than the Grand Canyon.

As man cannot lower himself to the depths these ocean experts wish to explore, a number of ingenious devices have been constructed for sampling the ocean.

One of the newest instruments, as well as the most intricate, records simultaneously the temperature and degree of saltiness of sea water, and the depth at which the instrument is operating. Connected to a recorder in the ship, it makes possible rapid determination of those variables vital to establishing surface and sub-surface ocean currents. The device cannot,

however, be lowered more than several hundred feet.

Samples of sea water, to be analyzed for iron, oxygen, salinity and alkalinity, are collected in Nansen bottles. In operation a half-dozen or so of these metal tubes, with both ends open, are hooked to a wire at pre-determined intervals.

When the bottles have reached the desired depth in the ocean and sufficient time has been allowed for their accompanying thermometers to record the water temperature, a small weight is sent sliding down the wire. This "messenger" starts a chain reaction which closes and inverts each bottle, and breaks the mercury thread in such a way that the temperature of the water at various depths can be read later.

Another way to obtain water temperature is to lower a bathythermograph or diving thermometer. This is used while the vessel is proceeding at normal speed. It records the temperature of the water against depth on a smoked glass slide, easily read.

Life in the sea is collected in silken nets, of cloth similar to that used for sifting flour. Some of the tow nets can be opened and closed at a given depth to keep the microscopic plant and animal life found there from being mixed with that living at another depth.

So many different types of animals exist in the sea that a net, dipped deep in the ocean, frequently yields a species never before seen. Marine scientists keep prying into the private life of all kinds of sea life, from bacteria to whales.

The bottom of the ocean is explored in a number of ways. Solid samples of sediment, for instance, are grabbed by an "orangepeel" dredge. Lowered with its jaws open, when it reaches the bottom this instrument automatically closes.

Cores are punched from the ocean bottom in much the same way that an apple is cored. Allowed to fall free as it nears the bottom, the coring tube is driven into the sediment by ballast, weighing up to 1,000 pounds.

One instrument stamps out short cores three feet long, another brings up sections up to 15 feet in length. The thin cross-section of sediment it brings up enables us to trace a million or so years into the history of the ocean, and of the world. From the remains of microscopic animals once living in the ocean, scientists can tell at what period the water was shallow, at what time deep; when warm and when cold.

Long cores of sediment up to 72 feet were obtained recently by a Swedish expedition on the research vessel Albatross. This instrument utilizes the high water pressure at great depths to force the sediment upward into the tube, while the tube in turn is pressed into the sediment by a heavy weight. Within the last few weeks a core measuring 30 feet 10 inches was secured by American oceanographers.

The gloomy appearance of the ocean and some of the sea animals that live three and a half miles down have been snapped by an underwater camera. The camera consists essentially of a fairly cheap instrument in a pressure-proofed housing, a trigger mechanism and a flashlight. When

the trigger, hung below the camera, touches bottom, a flash bulb goes off. Sea spiders, brittle stars, sponges or whatever else may be present are photographed in their native habitat. The vertical cliff walls of the submarine canyons have also been snapped.

More accurate charting of the location and velocity of ocean currents far out of sight of land has been made possible chiefly through the use of war-born Loran. This radio-navigation aid is particularly good in giving an accurate picture of a vessel's changes in position as she drifts or sails along. By tacking in and out of the edge of a current, an oceanographic vessel can determine the course of a current.

A trick used by oil geologists on land has been adapted to the sea. The thickness of the sedimentary carpet underneath the ocean can be determined by exploding a small bomb astern the ship. The first weak echo of the explosion is returned by the top of the sediment, the second strong one comes from the firmer rockbed beneath. Since sound is assumed to travel through the sediment 4,500 feet a second, the thickness of the sediment can be estimated by recording the time interval between the two echoes.

The bottom of the ocean is surprisingly rough, with many flat-topped sea mountains rising steeply from the surrounding muddy plains. In fact the plains are proving to be rather rare. In some places the sedimentary deposits are thousands of feet deep, in others the bedrock is practically nude. Findings such as these pose many questions to oceanographers.

Since oceans cover some 71% of the earth's surface, knowledge of their actions are important in peace as well as in war. The Oceanographic Division of the Hydrographic Office, Department of the Navy, has been set up as a clearing house for such material. On Naval expeditions planned for other studies, the office sees that someone with a knowledge of oceanography goes along. If something new is reported about the ocean, those who may best use the data are notified.

Step by step men are being trained to explore various phases of the ocean. Advanced courses in oceanography are given at Scripps Institution of Oceanography of the University of California, Yale University's Bingham Oceanographic Laboratories, the University of Washington at its Oceanographic Laboratories and New York University. Numerous scientists come each summer to the Woods Hole Oceanographic Institution for specific research.

Problems on underwater acoustics are studied at the U. S. Naval Electronics Laboratory at San Diego, the U. S. Navy Underwater Sound Laboratory at New London and the Naval Research Laboratory at Washington, D. C. The U. S. Fish and Wildlife Service specializes in biology of the sea.

Gradually the shape and character of the ocean bottom, and the action of the waters within the seas, are being revealed. Some day we may know much more about the history and origin of the earth because of studies of that larger portion of the earth hidded beneath the waves.

➤ With this garden-in-a-box you can have a little "farm" of the most modern sort, at any time of the year, regardless of weather.

Soilless Gardening

➤ **Anyone can learn about growing things and some of the principles of agricultural science by experimenting with this kit. The plants you raise will not lower the high cost of living but they will increase the pleasure of learning. Send for this kit today so you can get started on soilless gardening as a hobby. Grand for gifts.**

To Science Service
1719 N St., N. W.
Washington 6, D. C.

Send me..... SOILLESS GARDENING kits post-paid. Enclosed please find $4.95 for each kit ordered.

Name .....

Address .....

.....

C-4

NOW AVAILABLE!

SCIENCE SERVICE

Educational Filmstrips

- **Timely**
- **Authentic**
- **Instructive**

Ten titles—each strip complete with lecture notes; 37 to 67 single picture frames on 35mm. safety film.

Packed in individual metal can

$1.25 each

1. Antibiotics
2. Blood, The Stream of Life
3. Controlling Insect Pests
4. Fundamentals of Electricity
5. Knots and Ropes
6. Use and Care of Woodworking Tools
7. Working with Metal
8. How to Solder
9. Plastics
10. Youthful Scientists

To Science Service
1719 N Street N.W.
Washington 6, D.C.

Please send me the following Science Service Filmstrips for which I enclose $1.25 each: (Circle numbered titles desired).

1 2 3 4 5 6 7 8 9 10

Name.....

Address.....

.....

(City, Zone, State)

C 4